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ABSTRACT

One of a series of teacher-developed curriculum guides designed to encourage student participation and involvement in important social issues, this secondary level guide presents toxic waste as one example of a current issue requiring social action. The first section focuses on the skill of investigating as a means of introducing students to empirical methods, to the connection between science and social problems, and to an awareness of environmental issues. After completing readings on the biases of scientific studies and two case histories, student activities focus on identifying hazardous waste substances, finding out more about residential toxic waste, and exploring toxic waste treatment in their community. Lab activities dual with toxic waste and groundwater, testing soil and water, the effect of pH and salt on living organisms, and detection of heavy metals in water. Examples of active approaches to environmental problems are presented in the final section, in which students may: read about Rachel Carson, whose writing was influential in arousing public concern over the dangers of pesticides; discuss a toxic waste treatment program implemented in Denmark; examine government decision making; participate in a mock congressional hearing on toxic waste; and create a research plan for investigation. A list of resources concludes the guide. (LH)

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INVESTIGATIONS

Toxic Waste

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A Science Curriculum in the PARTICIPATION SERIES

SO 016 341

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INVESTIGATIONS: TOXIC WASTE

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FEEDBACK FORM

We see this book as a work in progress. Your comments, suggestions and additions will help us revise and improve its depth and quality. We would greatly appreciate your taking the time to share your reactions and any new ideas or materials.

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1. Which sections of this guide did you use? Which did you find most successful?

2. Which activities worked well for you? Do you have suggestions for improving them?

3. Which activities worked poorly? How could they be improved? Should they be deleted?

4. Overall, how did students react to this material?

5. Did the overview and introductory article help you teach the activities?

6. Did you share this guide with others in your school? What was their reaction?

7. If you have written an activity or have an article that you think should be included please send it to us. Your contribution will be noted among the list of contributors in the next edition.

EDUCATORS FOR SOCIAL RESPONSIBILITY is a national, non-profit membership organization of educators, parents, and concerned individuals who believe that the nuclear age demands new approaches to education. ESR is committed to presenting divergent views in the classroom on nuclear issues, war, and peace; to dealing with young people's questions and fears about the threat of nuclear war; and to fostering citizen participation in decision making about the nuclear arms race. ESR researches students' attitudes toward nuclear issues, assesses educational materials, develops curricula, sponsors conferences and professional development programs, and provides speakers and consultation services.

We would like to thank the ESR members and other contributors listed on the facing page for giving generously of their time and talents to write this Curriculum Guide. They generated, shared, refined and put down on paper their ideas for the exploration and teaching of nuclear issues. For their commitment and efforts we are wholeheartedly grateful.

The next steps are yours. Use this Guide in whatever ways are most appropriate for you. Let us know, via the Feedback Form on the next page, how it worked for you and how we might improve it. And, most important, please join your efforts with ours!

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PREFACE

In 1981, a group of teachers came together around a shared concern about the effect on children of living in a nuclear age. From this group emerged an organization, Educators For Social Responsibility, whose goal is to provide materials, education, and support for teachers and students in dealing with this issue.

Through research conducted in classrooms over the past three years, ESR has found that students express as they get older a growing sense of powerlessness and even cynicism about the possibilities for any individual or group to help create a better world. They do not identify inspiring models of individuals and organizations who have made a difference. Many view government as indifferent to public opinion and the reins of government as beyond their reach. They do not see themselves as creators of policy, but rather as cogs in a wheel of inevitability. In light of these findings, of the low voter turnouts in recent elections, and of the growing apathy among the general public, we are addressing the question, "How can we best educate to encourage conviction, commitment, and participation?"

This PARTICIPATION series is a first step in responding to that question. During the winter of 1984, a group of Boston area ESR teachers began brainstorming what a curriculum on participation might look like. Over a six-month period of thinking, writing, rethinking, and rewriting, these teachers developed five short curriculum guides as a start toward an education for involvement and action. We submit these to you as our initial response to a question we believe will stay with us for the rest of our careers.

We can think of no more important educational effort than helping children find their power and their place in creating a safe and peaceful future. We realize that this will challenge and stretch us as teachers. As you use this series and develop ideas and materials of your own, we hope you will share with us the results of your efforts so that we will all continue to grow in our thinking. Creating this series was empowering for those who participated. We hope it will be empowering to those who use it. In the words of a friend, "Our actions send ripples toward future shores." We thank you for your concern and courage in taking up this challenge.

Shelley Berman
Coordinator, Boston Area ESR
PARTICIPATION Project Coordinator

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OVERVIEW FOR THE TEACHER

Science and technology are big news. Scan the daily paper or tune in the TV news, and you will read or hear that some technological development has raised a hope or created a problem. Issues such as acid rain, nuclear power plants, pesticides, endangered species, genetic engineering, the space program, the arms race, test tube babies, and even the quality of American science education are constantly raised. Decisions about these issues are made every day in government and in business which will have great and long-term impact on our future.

For most people, our complicated technical world is both awe-inspiring and mystifying. Computers, lasers, and nuclear energy seem closer to magic than to the machines which most of us understand. Technological development moves rapidly -- so rapidly, in fact, that few adults can take the time to fully understand its nature or its potential impact. Often we make the assumption that technology is in itself desirable. We connect it with growth, newness, and prosperity. We do not question its value or even understand that it is a choice. It will be difficult for today's students to make intelligent decisions in the 21st century without an understanding of how scientific and technological developments affect their lives. To be effective citizens, they will also need to know how they shape and are shaped by society's values and political decisions.

In preparing this curriculum we attempted to keep both these needs in mind. We have outlined a unit which can act as a model for units on a wide variety of issues. It focuses on the relationship of technological development, its impact on society, and government and business decision making. Through this curriculum we hope to develop the skills discussed below which are essential to making well-reasoned judgments both in science and in everyday life.

THE EMPIRICAL METHOD AND PROBLEM DEFINITION

We extend the process of science, the empirical method, to other areas of students' lives in which it is necessary to think logically and make careful, reasoned decisions. Students move through the steps of defining a problem, examining the available data, formulating a hypothesis to explain the data, testing the hypothesis through experiments or other empirical means, analyzing the results, and drawing conclusions. We place particular emphasis on correct experimental technique.

EVALUATING INFORMATION AND ITS SOURCES

This unit concentrates on evaluating information and opinions presented by the media, scientists, government, and industry. Perhaps the primary skill we focus on is the capacity to analyze critically information and positions relevant to social issues. Students learn to ask such questions as, "How do people's values, assumptions, and interests shape the information and positions they take?", "Are their positions based on reliable data?" and "How does your own value system influence how you use the facts to make your decisions?" Sensitivity to such questions can lead students to a more objective consideration of problems.

UNDERSTANDING THE DIFFERENCE BETWEEN SYMPTOM AND CAUSE AND ACCEPTING IMPERFECT SOLUTIONS

In order to solve problems quickly, we often use short-term remedies. In this unit, students are asked to consider whether or not such solutions correct the situation or, in fact, have long-term detrimental consequences. They are encouraged to examine the root of the problem and make judgements on the most appropriate short- and long-term solutions.

The result of pursuing critical-thinking methods is the recognition that there may be no perfect solutions. Many of the facts we would like to know before we make decisions may not be available to us within that time frame. In many cases, the best we can do is to create and evaluate sound reasons for pursuing a course of action, weigh facts and alternatives against one another, accept that the consequences will always be somewhat uncertain, and act according to our best judgment.

TAKING ACTION

This unit is based on the assumption that citizens in a democracy have a voice in decisions which affect their lives, and that they should exercise their voice. Once we have defined problems, sought relevant facts, analyzed the facts and other information, clarified values, and weighed possible solutions, it is time to act. The unit leads students to identify individuals and institutions pertinent to the scientific problem under investigation, and encourages them to take an active role in determining the values and policies that these institutions take.

We also attempt to explore science in a way that is relevant to all segments of society. We have tried to do this by integrating the different dimensions of science and the different interests of people as they look at science. The unit is addressed not just to future scientists, but to all students.

We assume that scientists and others involved in the development and management of technology have a great deal of responsibility to society.

Their work affects all of us. Because many people remain unaware or uncomprehending of many technological changes, we are often dependent on the concern and integrity of the few people who do know. We also assume that each citizen has a responsibility to enter into the decision-making process in an informed and thoughtful way. Both scientists and citizens must seek together to see that our scientific efforts are used for the well-being of society. What constitutes the well-being of our society is often decided in a political forum.

Our goals for the teaching of science are ambitious. Because of its limited scope, this unit of study can make only a small contribution toward realizing them. We hope, however, that its example will point the way toward utilizing other topics to teach responsible understanding of science and technology and informed decision making.

The topic we have chosen to explore is toxic waste. This issue, a nationwide problem affecting all levels of society, receives a great deal of media attention. In addition, the subject is pertinent to most areas of academic science and can be adapted to fit into almost any curriculum.

This unit can be effectively used during an election period. We suggest that the section on "Investigating" be used to introduce students to the empirical method, to the connection between science and social problems, and to an awareness of environmental issues during the campaigns. It can be taught as a complete unit or can be divided into parts to fit appropriately into the year's curriculum. In chemistry, for example, waste treatment might be taught when discussing methods of separation. We urge you to select the sections that you find suitable for your course. All student readings and handouts may be reproduced for use in the classroom.

In addition, toxic waste is presented here as just one example of a current issue. The same method can be used to teach about many other problems affecting society. We encourage you to adapt the unit to any of the topics presented at the beginning of this overview. Furthermore, we suggest that science teachers collaborate and team teach with social studies teachers wherever possible, thus modeling even more dynamically and realistically the interaction between science and society.

According to recent appraisals of science education, when socially-relevant issues are discussed in class, students are more motivated to study and become better scientific thinkers. We hope that this unit will help you accomplish these ends.

TEACHER'S INTRODUCTION TO INVESTIGATING

The first section of our curriculum focuses on the skill of investigating. Through it we hope to provide students and teachers with a better understanding of the toxic waste problem. Teachers are encouraged to inform their students that information about hazardous waste is new and being supplemented constantly, therefore, the unit will be a learning experience for everyone. By so doing, teachers free themselves from feeling that they must always be experts before they approach a topic, and, more importantly, they shift the responsibility of research to students. Since one goal of this curriculum guide is to teach students how to learn more about important issues, it is vital that they take the initiative to call local officials, contact organizations, and do library research. Providing the opportunity to find out on their own is sometimes more important than instructing. Teachers are urged to participate equally in the following activities and share what they have learned with the class.

The first activity is an introduction to scientific methodology and thinking, and, therefore, can be used in any science course. The class examines the nature of scientific studies and the way they are presented to and by the media. The examples given are directly related to toxic waste; however, the activity can be used whenever scientific articles appear in the news. You might want to have an article presented to the class weekly, followed by an evaluation of its accuracy and impartiality.

As an introduction to toxic waste, students will read several case histories and answer questions based on them. It is very important to discuss all these questions since many of them demand value judgments. Emphasize that there are many possible answers to these questions depending on one's opinons and interests. For this reason, the toxic waste problem is a complex one.

The next activity, a home toxic waste survey, gives very little background information. Instruct the class not to worry about including incorrect items, just to do the best they can. After the survey, have one student write his or her list on the board and have others add different substances to it. Discuss the merit of the list, deleting obviously incorrect items. Have students help categorize the substances into such groups as cleaning agents (toilet cleaners, oven cleaners, chlorine bleach, furniture polish), pesticides, herbicides, car needs (fuel, anti-freeze, oil, wax), and paint and related items (removers, thinners, varnish). Discuss the ingredients of these groups and the difference between biodegradable and nonbiodegradable items, and have students suggest ways in which they might be toxic.

Following this activity, students should be given the opportunity to

better acquaint themselves with the nature of toxic waste. This process can be accomplished by having them research the subject on their own, through class lectures, or by assigning them the reading material included with this unit. In any event, we suggest that the class discuss the following two issues:

1. Who should be held responsible for production of toxic waste: industry, the government, or the consumer?

2. What are the best ways to avoid the problem of chemical waste?

One way to approach the second issue would be to brainstorm all the alternatives and then look at their implications. For example, students might arrive at the following alternatives and implications:

1. Require the industry to dispose of their wastes properly -- Would this increase the cost of products?

2. The government must dispose of all wastes -- Would this either increase taxes to industry and/or the consumer or take tax money away from other programs?

3. Stop producing items that cause this waste -- Would consumers have to give up or find substitutes for many useful goods and luxuries, and/or would industry have to develop new methods of production?

By participating in such a discussion, students can begin to appreciate the many facets of the toxic waste issue.

During the next activity students continue to collect data and increase their understanding, but also become educators. Allowing them to inform adults gives them the sense that what they do is important and can cause change. Such a feeling is a prerequisite for action.

The section on waste treatment once again asks students to consider the economic and political aspects of this issue. By having them focus on their own community, the problem becomes more real. Most people would answer the question, "Would you live next to a waste treatment plant?" with a definite "No!" That answer then raises the questions, "If you wouldn't, who would?" and "How does a community decide where to place a treatment plant?" If a more detailed study of alternative treatment is desired, students could be assigned research reports and give oral presentations in class.

At this time students can be given assignments to contact local officials to find out about residential treatment facilities in their area. Different students can be told to call different agencies and individuals and then report their findings to the class. In addition, local politicians could be invited into class to explain their stands on toxic waste, and what they are doing for the area.

Through their hazardous waste survey, students probably found that

most home waste ends up in the local landfill. A fieldtrip to the dump and/or interview with the landfill management are good ways for the class to learn what happens after the waste leaves their homes. Students should be prepared to ask questions and make observations. In the activity description, students create a questionnaire. This procedure may be done independently or as a class project. During a post-investigation discussion on the adequacy of the facility, the class should be made aware that their findings may not be completely correct. If there is sufficient reason to think that the facility is not safe, the class should decide whom to contact so that further studies can be done.

The above activities, using interviewing and fieldtrips, introduce students to how one goes about seeking information about political issues. Before they can fully evaluate and act on a problem, they need to learn where and how to obtain data.

STUDENTS' INTRODUCTION

The problem of hazardous waste will demand more of our attention as time goes by, if for no other reason than that more and more of these dangerous materials are being produced each year. In 1980, the Environmental Protection Agency estimated that industry alone produced 57 million metric tons of toxic waste. More recent estimates triple that amount. It is very difficult to determine how much is discarded each year by households.

Nor is it always easy to distinguish between hazardous and non-hazardous waste. Household ammonia, for example, is harmful to inhale or swallow, but when poured down the drain, it is neutralized by acidic substances.

It is clear, however, that the amount of hazardous waste created each year has doubled several times in the past thirty years, and we can expect the increase to continue. Will our methods of controlling and disposing of wastes keep pace? This unit will help you form an opinion about this and related questions. It will also provide a way in which your investigations of hazardous waste can produce a document which could be of considerable value to your community.

READING ON BIASES OF SCIENTIFIC STUDIES

Science enters our lives all the time. We learn of new scientific discoveries and of political decisions on scientific issues through newspapers, magazines, television, and school. Do we fully believe everything we see and hear, or do we question these news reports? In addition, do scientists harbor similar biases and prejudices as the rest of us, or do they see themselves as neutral?

The image of science is one of searching for truth objectively. A science lab is supposed to be a neutral environment, and the scientists in it neutral observers. In reality, however, science is no more free of bias than the society in which it exists. Society's interests and prejudices shape all aspects of the scientific process, from the selection of who becomes a scientist to the choice of research projects to the experimental results. Think about designing, performing, and interpreting an experiment. Where do you think a scientist's interests might influence this process?

Let's start with the choice of a research topic. Much of this decision has to do with the interest of the scientist and his or her employer. That employer may be a university, the government, or an industrial company. For example, a chemist working for a company which produces pesticides would approach his topic very differently from one who was working with an environmental group. Another factor in the choice of research is how the scientist will get money to pay for it. Scientific equipment, lab space, and technicians are very expensive. A scientist who works for a big company generally has more funds available to her than one who works for a university or non-profit organization. These latter scientists often must get grants elsewhere, commonly from government organizations such as the National Science Foundation or National Institute of Health.

Bias also enters the scientific process in two other significant ways: when the scientist designs the actual experiment and chooses experimental subjects and controls, and in unconscious or intentional manipulation of data. Data can be presented in such a way as to seem to support certain preconceived notions. Then, when data is interpreted, one's point of view and assumptions can determine what conclusions one draws from particular data.

The following article demonstrates how the value of an important study can be questioned because of faulty experimental design and procedure. After reading the article, think about how you might have designed the study differently.

FIRST READING ON BIAS: Results of Harvard-Woburn Health Study Questioned by Experts (From Waste Management Report Parlow. Boston, June, 1984. pp.1-2.)

Last February, a major health study of Woburn residents exposed to hazardous wastes was released by the Harvard School of Public Health's Department of Biostatistics. The study's researchers announced that "positive associations" had been identified between (1) the incidence of childhood leukemia, perinatal deaths, and some birth defects, and (2) the availability of water from Woburn wells G and H. Those wells were closed in 1979 when contamination with well-know carcinogens was discovered.

The report has drawn national attention, and is regarded by many as one of the strongest pieces of scientific evidence to tie -- albeit inconclusively -- serious illnesses with exposures to specific industrial chemicals.

For years, a debate throughout the country has questioned whether large numbers of cancers and other diseases are in fact linked to identifiable chemical exposures, despite scientific difficulties in documenting the link; or whether (alleged) environmentally-based disease is instead a result of exposure to the full array of carcinogens in our society: from cigarettes, to radon, to pollutants transported from the Midwest as well as from a plant nearby. The Harvard-Woburn study supports the link between disease in Woburn and a single industrial-based source.

However, the chairman of the Harvard School of Public Health's Department of Epidemiology called the Woburn report "a very bad study," adding that "a great deal too much is being made of it." Speaking before the Massachusetts Special Commission on Liability For Release of Hazardous Material, Dr. Brian MacMahon pointed to the following problems in the Woburn Study:

-- use as interviewers of people with an emotional stake in the outcome of the study (much of the survey's data collection was carried out by a Woburn citizen's group, For A Cleaner Environment);

-- reliance on small numbers -- e.g., inferring "significant" associations based on only three cases;

-- inclusion of only 55% of the target population; 3000 telephone calls were just not made, with no explanation given;

-- naive medical and biological knowledge, as evidenced by the invalid grouping of malformations with very different causes.

For a study of this nature, MacMahon observed that the true test of whether its findings will be accepted within the scientific community is publication in a professional journal. But of this study, he said, "I don't know any journal that will accept it."

Inconclusive

Questionable scientific procedures were also attributed to the Woburn study by Dr. Renate Kimbrough, toxicologist with the Center for Disease Control (CDC) in Atlanta. In testimony presented to the Massachusetts Toxic Tort Commission, Kimbrough stated, with reference to the study, "I am not impressed that the contamination of wells G and H with solvents had any effect on disease incidence in the Woburn area." She observed that the "organic contaminants [for which the wells were closed] are all in the parts per billion range and are no higher than what has been found in many other areas in the United States," and, further, that "none of these solvents have been associated with the induction of leukemia or cancer..."

"I am not able to draw any conclusions," stated Kimbrough, "as to whether any of the reported health problems are associated with living in Woburn." Among the items she critiqued were:

-- lack of clarity in the report as to how it measured the contributions to town water from wells G and H, and a lack of information about possible pollutants in the other town wells;

-- use of non-standard criteria for perinatal mortality, such that comparison with other studies may not be possible;

-- lack of clarity regarding the cumulative exposure of leukemia victims and a control group to wells G and H, and a possibility that children in a control group were exposed to the contaminated wells at levels "approximately equal" to the levels for most of the leukemia victims.

Kimbrough advised that further study be conducted as to occupational exposures in the Woburn area, and "the plausible routes of exposure for the children to carcinogens." She observed that chemicals used in the Woburn area -- tanning products, nitrosamine wastes, and lead arsenate -- while not present in the town water, are associated with certain cancer risks.

Discussion Questions:

1. What faults did Dr. MacMahon and Dr. Kimbrough point to in the Woburn study?

2. What interests might the For a Cleaner Woburn citizens have that could bias the study?

3. What expertise do the two doctors have? Would they have a particular bias? In their position of authority are they more likely to be conservative in reaching conclusions?

4. In any study of the environmental causes of cancer, what makes it difficult to draw links between the causes of cancer and the individuals who come down with it?

5. Do the faults with the Woburn study mean that the contamination of wells G and H did not produce cancers in Worburn residents or that the study was not conclusive in proving the link?

6. If you were a Woburn resident what action would you propose the city take in light of the study and this evaluation of it? How would you go about recommending this to the city?

7. Would you drink the water in Woburn?

SECOND READING ON BIAS

Scientists are not the only ones who are prone to interpret data prejudicially. The public receives most of its scientific information from the media. The media is very selective in the information it presents and how it is presented. In addition, conclusions depend on the source of the information. Opposing groups often have different economic or social interests that call for opposite conclusions.

During the first part of President Reagan's administration, he received a great deal of criticism from environmental groups and the media for what they viewed as appointments and policies which dismantled the web of regulations protecting the environment. Ann Burford, President Reagan's appointment as the Environmental Protection Agency (EPA) administrator, resigned because of a controversy over her relationship to business interests. The President then appointed William Ruckelshaus who had been head of the EPA during President Nixon's administration. In the following speech by Mr. Ruckelshaus and an environmental group's reaction to his policies you will be able to examine how differently data is interpreted and presented.

RUCKELSHAUS REVIEWS YEAR AT EPA (from EPA Journal, May, 1984)

In a recent speech to the National Wildlife Federation EPA (Environmental Protection Agency) Administrator William Ruckelshaus reported on progress made in the first year of his second term as Administrator. Here are excerpts from his remarks:

"EPA has survived a difficult period of uncertainty and I think it's fair to say is now on the right track again. At the risk of sounding self serving, I believe that during the last ten months the agency has regained its morale -- and we are doing what the law says we should be doing.

"This recovery of a sense of direction at EPA may have been inevitable, considering that the American people have expressed their commitment to the protection of public health and the environment in a broad array of legislation and citizen action over the past two decades. They value their environment deeply. That's why public support for the values EPA was created to protect has been so strong and persistent.

"Shortly after returning to EPA, I was given a report card by the Izaac Walton League. It was really more like a list of required courses with some pointed suggestions for fast action. The League was deeply concerned about the size and general thrust of EPA's budget, water quality issues, control of toxics, the clean-up of hazardous waste and our acid rain policy.

"Those were the very issues we at EPA were concerned about and I

told the League that they would receive our immediate attention. They have. We have followed through and we have done well, almost certainly better than realists though was possible in so brief a time.

"First, the budget. With the President's support I asked the Congress to provide additional funding for Fiscal Year 1984, and as a result, our operating budget has risen 27 percent overall since last May -- 47 percent if you include the Superfund. (The Superfund is an EPA managed fund designated for the cleanup of the most immediately dangerous hazardous waste disposal sites.) Growth of the Superfund between May 1983 and Fiscal Year 1985 will exceed 100 percent -- up from $310 million to $640 million. In an era of huge deficits and great pressure on domestic spending this isn't bad in 10 months.

"Second, water quality. We reversed a previous EPA decision to downgrade water quality regulations. We have issued new rules that will make it easier for the states and the federal government, working together, to fulfill the intent of the Clean Water Act. We have set an effective process for altering standards where necessary, and tough anti-degradation requirements have been retained. We have task forces hard at work examining a number of urgent water related issues, such as nonpoint source pollution, waste treatment plant construction grants, ground-water management, pollution monitoring and clean-up of toxic waste dumps.

"Third, control of toxics. We have taken action to phase out EDB, develop a strategy for control of dioxin, regulate benzene, address the threat of PCBs, and initiate rulemaking on asbestos in schools, to cite only a few.

"EDB perfectly illustrates our more aggressive attitude these days. Nobody had done much about EDB for ten years, despite mounting evidence of hazard, until the new EPA took action to get this unacceptably risky compound out of the food chain.

"Fourth, hazardous waste. We will continue to stabilize imminent threats at uncontrolled hazardous waste sites through Superfund removal actions. In Fiscal Years 1984 and 85 we shall complete 300 emergency clean-ups. We have placed 546 of the most dangerous locations on our National Priorities List for early action because they pose the greatest risk of air, ground-water and surface water contamination.

"Clean-up is moving much faster now that we've dropped our requirement that the states pay 10 percent of the upfront costs of planning. We've delegated more authority to the EPA regions and adopted a philosophy of clean-up first -- we can decide later who pays for it.

"We intend to use the Superfund remedial program to complete long-term, complex site cleanups. We have identified more than 17,000 hazardous waste sites in this country already and we estimate the total may go as high as 22,000. We are working virtually around the clock with the states to complete our site survey, rank the sites by degree of hazard and study long-term effects on public health.

"We will move vigorously to reduce the number of violations by major waste handlers.

"Fifth, acid rain. This has been my biggest disappointment. I've been trying to forge a consensus on this complex problem but none has emerged as yet from the whirlwind of conflicting opinion and diverse interests. I'm determined to continue to work to find a formula that will permit us to address this problem effectively.

"We have boosted our acid rain research budget from $15.4 million to $34.4 million in one year. The federal interagency acid rain effort will double to $55.5 million for research to support a national survey of some 2,000-3,000 lakes, plus periodic monitoring of several hundred lakes to establish baselines, determine actual damage and lay a foundation for appropriate action. And we are planning additional studies to determine whether acid rain has caused damage or changes in rate of growth and species composition in forests.

"We are working with our state agency counterparts to be ready to put a control program in place when Congress and the Administration can agree on the need and structure for it.

"Despite the public demand for action it is more difficult to pass environmental legislation today than a decade ago. For one thing, the opposing sides seem to be further apart. And the positions of the major players are not likely to soften during this election year. So it won't be easy to make major breakthroughs on our legislative agenda in 1984.

"In any event, the current concern about acid rain should not obscure the very real progress in cleaning the air that is being made. At the end of a recent five-year period pollutants in all six categories controlled by the Clean Air Act were trending down. To cite just one dramatic example, if the clean air legislation had never become law, sulfur dioxide emissions would have reached 40 million tons nationwide by 1980 instead of 27 million.

"Ours is probably the only age that has ever cared about the environment as an entity or ever had even modest resources to do something about it. In a little over two decades we have evolved from blithe indifference to irrevocable commitment, and I have no doubt that by the turn of the century this country will be safer and less defiled than it is now — even if we do no more than enforce existing laws.

"My optimism springs from a realistic assessment of where we were in comparison with where we are.

"Elsewhere in the world things are not so good. Indeed, the real challenge during the 80's and 90's may be to export environmental consciousness. You launched your magazine International Wildlife in 1971 in recognition that the earth constitutes but one ecosystem. Now that perspective is more vital than ever.

"We are on the move, and I believe with ever more resolute

conviction that nothing, save deliberate self-destruction, can stop mankind from creating a higher form of planetary civilization."

(Copies of the full text of this speech by Aministrator Ruckleshaus to the National Wildlife Federation in Atlanta, GA on March 17, 1984 can be obtained by writing to the EPA Journal.)

Discussion Questions

1. Do you think Ruckelshaus is speaking from his individual point of view or from his official government position? What might be the purpose of this speech?

2. What does Ruckelshaus see as the real improvements in environmental quality?

3. Why does he say early in his speech, "We are doing what the law says we should be doing?

4. What does Ruckelshaus think still needs work?

5. After reading his speech, do you feel optimistic or pessimistic about the future of the environment? What aspects of his speech make you feel this way?

6. Ruckelshaus seems proud that the EPA will be cleaning up 300 of the 1700 identified hazardous waste sites. How would an environmental group interpret this record?

RUCKELSHAUS REPORT CARD: A GENTLEMAN'S "C" (by Judith Kunofsky, Sierra, January/February, 1984, pp.31-33,146-148.)

William Ruckelshaus has now been administrator of the Environmental Protection Agency (EPA) for about a third as much time as his predecessor, Anne Gorsuch Burford, served. He has had seven months to put the agency back on the road to protecting the environment. How has he done? Is the agency once again making significant progress in protecting the nation's environment and public health?

The answer is "yes and no." The EPA is recovering from the debacle of the Burford era, but on the issues of greatest concern to the Sierra Club, Mr. Ruckelshaus's performance is not yet adequate....

Ruckelshaus set out to end the divisions between career civil servants and Burford-era political appointees. His first appearance at the EPA offices prompted a hero's welcome from the staff. He has restored the "open door" cordiality that existed between environmentalists and previous EPA administrators. Virtually all the Burford appointees have left, and Ruckelshaus has appointed a number of competent and committed people to key staff positions.

Yet, in the areas the Sierra Club is most concerned about, Ruckelshaus's proposals have been too weak, his bad decisions too numerous, and his major initiative -- acid rain control -- thus far a failure.

Testifying on Ruckelshaus's appointment before the Senate Committee on Environment and Public Works last May, the Sierra Club identified four areas of particular concern: clean air, clean water, the agency's budget, and the Superfund program to clean up hazardous-waste sites. Let us review what has happened in each of these areas.

Clean Air. Some environmentalists had hoped that, with Ruckleshaus in place, the Reagan administration would finally come up with a plan to protect those parts of the country now suffering the effects of highly acidic rain....

The result has been very disappointing. Sulfur dioxide is the main culprit in acid rain; the proposal being considered within the agency would provide as little as one third and no more than two thirds of the reduction in sulfur-dioxide emissions necessary to protect the Adirondacks, and less than half the reduction needed for New England. The Great Smokies, the upper Midwest, and the entire western United Stateswould receive essentially no protection....

The Clean Air Act provides for identifying and regulating toxic pollutants -- those particularly dangerous substances that, even in tiny amounts, can cause cancer or other serious diseases. The EPA has identified only seven substances as hazardous air pollutants, and has issued regulations for only four of those.

Congress, in debating reauthorization of the Clean Air Act, has been considering measures intended to force the EPA to deal with toxic air pollutants. During the Burford era, environmentalists certainly expected no progress in this section of the act. But even from the Ruckelshaus EPA there has been little good news. No new substances have been formally declared hazardous, despite the fact that the EPA has been studying 37 chemicals for at least six years, 11 of which have been identified as carcinogens by the U.S. Department of Health and Human Services....

Clean Water....Ruckelshaus has issued good revisions to regulations on water-quality standards. In so doing, he rejected a series of disastrous changes proposed earlier by the Burford EPA. The new regulations require both that states establish limits on the toxic substances allowed in their waters, and that they take those limits into account when designing the permits that polluters must obtain. The regulations also toughen the criteria under which high-quality water can be degraded.

Ruckelshaus has received praise for issuing these regulations -- but does he deserve credit? He was already under pressure to reject Burford's bad proposals. If he had not done so, Congress in all likelihood would have added tough language to the Clean Water Act to make the earlier Burford proposals impossible to enact.

Furthermore, the new water-quality regulations do not require the states to issue "numerical" standards; instead they permit them to meet such vague requirements as keeping waters free "from toxics in toxic amounts." The House draft of the proposed amendments to the Clean Water Act would require numerical standards -- which Ruckelshaus was unwilling to propose on his own.

The EPA Budget. Environmentalists urged an EPA operating budget (not counting the separately financed Superfund program) of $1.3 billion for fiscal 1984. This amount is the same as the agency's budget for fiscal 1981, the last budget bearing the stamp of the Carter administration. The request seemed a modest one, given both inflation since 1981 and the agency's need to substantially increase its activities to deal with toxic substances. Yet even with Ruckelshaus at EPA, the administration's request fell far short of this amount.

Initially, Ruckelshaus had said he would not have time to prepare recommendations for fiscal 1984. But momentum was building in Cingreee to reject the administration's proposal of only $949 million for the EPA and to appropriate $1.3 billion instead....

Ruckelshaus finally delivered his promised budget the evening before the full committee voted, proposing to increase the operating budget to $1.1 billion. This 16-percent increase over the original Reagan request would, he said, "fund an aggressive environmental cleanup effort." The Senate went along with Ruckelshaus's request, as did the House.

The final operating budget puts the EPA's purchasing power back at the level of 1974, although virtually all of the agency's major responsibilities for toxic substances -- including safe drinking water,

hazardous-waste regulation, and portions of the Clean Air and Clean Water acts -- came after 1974.

Superfund. The Burford EPA was a disaster when it came to implementing the Superfund program, and one of Ruckelshaus's highest priorities upon his return to the agency was cleaning up the nation's worst hazardous-waste sites. The EPA is now investigating many more sites, is moving ahead more quickly with remedial actions, and has eased financial requirements for states -- all good steps.

The EPA has started cleanups even before beginning negotiations with potentially liable companies and individuals — a procedure intended by the Superfund law itself but rejected by Burford.

The Burford EPA had carried out lengthy negotiations with polluters and had reached some out-of-court financial settlements that environmentalists and many in Congress regarded as scandalously low. Under Ruckelshaus, the EPA has proposed new guidelines to ensure that companies offer to pay at least 80 percent of the cleanup costs — or be taken to court. Yet, under these proposals, the 80 percent applies to only "surface" pollution, which ignores the much more difficult and expensive work of removing toxic pollutants from groundwater.

Other Issues. After a 10-year fight, the EPA in October 1983 banned most agricultural uses of ethylene dibromide (EDB), a pesticide known to cause cancer....Two week after its ban on EDB, the agency announced it was not going to proceed with efforts to prohibit most uses of Lindane (hexachlorobenzene), a cancer-causing chemical that is also an insecticide often used in shampoos prescribed for children infested with lice. In 1980 the Carter administration had proposed a virtual ban of the substance, citing evidence that it causes cancer and birth defects and is acutely toxic to aquatic wildlife.

...Just after the EPA had issued good water-quality regulations, the agency made public its decision to reregister sodium fluoroacetate (Compound 1080), a controversial poison used by sheep ranchers to kill coyotes (and any other animal that happens to take the poisoned bait)....The recent EPA decision enables ranchers once again to make widespread use of Compound 1080, which poses a great danger both to coyotes that do not kill sheep and to other wildlife. Ruckelshaus declined (for no stated reason) to personally participate in making the recent 1080 decision.

William Ruckelshaus has restored peace to the EPA, at least as measured by staff morale and press coverage. Yet, as Sierra Club Executive Director Mike McCloskey put it: "Looking at Ruckelshaus's actions so far, we have to say that, as EPA administrator, his best years lie behind him." Outsiders will probably never know whether to attribute the lack of consistent progress in many key environmental areas to Ruckelshaus's unwillingness to tackle these problems or to ideological opposition to environmental protection on the part of the rest of the Reagan administration.

What is certain is that environmentalists have succeeded in making Reagan's environmental policies a major political concern, one that Reagan wants to defuse as a campaign issue. Bill Ruckelshaus's record so far has been disappointing. It's up to environmentalists to keep a spotlight on the EPA to convince Reagan and Ruckelshaus that tough, well-enforced environmental protection is the only way to satisfy the public in 1984.

Discussion Questions

1. Compare what Ruckelshaus said he accomplished with the points made in the Sierra Club article. Break this down into the categories of: redeeming EPA's reputation, quality of staff, clean air, clean water, the EPA budget, Superfund, and other concerns. Do the fact differ? On what do these two articles agree? On what do they differ? Ruckelshaus claims success. The Sierra Club is not as enthusiastic. What accounts for their differences in perception?

2. What are the environmentalists saying about how economics and politics influence government policies and decisions? What pressures might Ruckelshaus experience from President Reagan, business, and environmentalists?

3. What different measures of success are used by Ruckelshaus and the environmentalists?

4. Ruckelshaus said, "EPA...is on the right track...We have followed through and done well." This seems to be disputed by the environmentalists. How would you determine who is right? How would you determine whether the EPA is doing all it should and doing it well? How would you best be able to judge a President's commitment to preserving the environment?

5. Does this second article make you feel any differently about Ruckelshaus' speech? Explain.

6. After reading this article, what questions about toxic waste would you ask Mr. Ruckelshaus?

CASE HISTORIES: READINGS FOR STUDENTS

In the next few pages you will read two actual accounts of the harm that came from toxic waste. While reading these case histories, try to look at the problem through the eyes of the private citizen, public officials, the transporter, and the generator. Consider all the options open to these individuals, and evaluate their actions. After reading the material, you will be asked to answer several questions concerning the participants' roles and the complexities of the cases. Before beginning you will want to look up the following terms:

1. Aquifer
2. Permeable
3. Fumigant
4. Percolate
5. Groundwater
6. Landfill

Chemical Pollutants in Lathrop, California

Lathrop is a small town (population 5,000) in the San Joaquin Valley about seventy-five miles east of San Francisco and ten miles south of Stockton. Several companies have manufacturing plants there, including Libby-Owens Ford, Air Products, Inc., and Occidental Chemical Company. The vast majority of the land in and around Lathrop, however, is utilized for agricultural purposes. Water in the Lathrop area is a scarce and valuable resource. Lathrop's residents, farms, and industries rely almost totally on groundwater obtained from wells sunk into the sandy and porous soil.

In 1979, Lathrop was stunned by news that its only water resource was contaminated with dibromochloropropane (DBCP), a soil fumigant known to cause cancer and sterility.* The company suspected to be the source of contamination was Occidental Chemical, also known as Oxychem, a division of Hooker Chemical Company. The Lathrop plant began manufacturing fertilizer in 1953. In 1964, it was purchased by Occidental, which greatly expanded its operations. The facility sits less than thirty feet above a major aquifer, which supplies the Lathrop area with its drinking, manufacturing, and irrigation water. The soil in the area is extremely permeable, and liquids dumped on the surface are readily absorbed into the underlying soil. The absence of impermeable strata between the surface and underlying aquifer ensures easy downward migration of pollutants.

Over the years, the plant manufactured thousands of tons of fertilizer and fertilizer constituents, including sulfuric acid, phosphoric acid, ammonium sulfate, and ammonia. The plant also formulated and packed for sale over fifty pesticides. One of the pesticides formulated at the Lathrop plant between 1963 and 1971, and again between 1974 and 1976, was DBCP.+

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*DBCP was initially marketed as Fumazone(r) by Dow Chemical Company in 1957, following a six-year testing program, and subsequently as Nemagon(r) by Shell Chemical. The first publication on the toxicology of DBCP in 1961 reported that it induced sterility, testicular atrophy and inhibition of spermatogenesis, in various species and that these effects, together with growth inhibition, were seen in rats inhaling 5-ppm levels, the lowest dose tested. Subsequent studies confirmed its sterilizing effects (1971) and also demonstrated the induction of gastric cancer in mice and rats and breast cancer in rats after only brief periods of exposure (1975) and mutagenicity in bacterial and other systems (1977). Over this twenty-year period, no warning at all was given to the workers at the Lathrop plant or elsewhere concerning the extreme reproductive and other hazards of DBCP.

+In 1977, workers at the Lathrop plant, worried by their infertility, prompted their own medical examination. Of twenty-three workers exposed to DBCP, nine were found to have no sperm at all after working in the plant for fifteen years, while others who had been employed for shorter periods had a marked reduction in sperm count. Following similar findings elsewhere, at Dow and Shell facilities, DBCP production was

Until 1977, the plant took minimal precautions in disposing of its pesticide wastes. Most were dumped directly on the plant grounds or into an unlined lagoon with a porous base. Both practices were in clear violation of California state law, which requires any company dumping a chemical waste that could percolate into groundwater to promptly report the dumping to the California Regional Water Quality Board. As evidenced by internal memoranda, made public in June, 1979 by Congressman Bob Eckhardt's Oversight and Investigations Subcommittee, company personnel were well aware of this violation but continued to dump and to withold this information from the state.

The documents demonstrate that, as early as April, 1975, Oxychem personnel were aware that their pesticide operation violated state law. Robert Edson, the facility's environmental engineer, told company officials that allowing waste percolation into the ground was clearly against the law.*

According to Edson, who had been complaining about the problem for years, the situation had already become dangerous. "Our laboratory records indicate," wrote Edson, that we are slowly contaminating all wells in our area, and two of our own wells are contaminated to the point of being toxic to animals or humans. THIS IS A TIME BOMB WE MUST DEFUSE [emphasis original]."

Impressed by Edson's concerns, Lathrop management informed Oxychem's comptroller at Houston headquarters that it would need immediate funds to stop the pollution before the state caught up with it. Mr. A. Stanek, the Lathrop plant manager, wrote, "Should the water quality control regulatory agencies become aware of the fact that we percolate our pesticide wastes, they could justifiably close down our entire AgChem [Agricultural Chemical] plant operation." Despite these warnings, cleanup money was not made available that year, and the coverup continued.

By June, 1976, Edson was getting very nervous. "I believe we have fooled around long enough and already over-pressed our luck," he wrote. Edson's estimates of the plant's discharges showed that an excessive amount of hazardous wastes had already been dumped. "To date, we have been discharging more than 500 parts per million or about 5 tons of pesticide per year into the ground. The next drop of pesticide that

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suspended by the Occupational Safety and Health Administration (OSHA) in September, 1977. Worker exposure at the Lathrop plant was estimated by the National Institute for Occupational Safety and Health (NIOSH) to be in the region of 0.5 ppm.

*These regulations were spelled out in detail to Oxychem in August, 1968: "The waste discharge shall not cause a pollution of ground or surface waters .... The waste discharge shall not cause concentrations of substances in usable ground waters, which are deleterious to human, plant, animal, or aquatic life."

percolates to the ground is a management decision I don't feel we can afford."

Edson was especially concerned about a neighbor's drinking water well, located only five hundred feet from the point of the plant's waste discharge, and warned that he "would not drink from this well." Later that year, the plant sampled this well and found 2,000 parts per billion (ppb) of solvents, a level far exceeding health standards. The neighbors were not informed of the danger.

Further tests taken in 1977 revealed that other plant operations had also heavily contaminated local groundwater. In an April, 1977, memorandum, Edson wrote, "We have destroyed the usability of several wells in our area." This new information, together with the plant's failure to abate the problem, led to Edson's refusal to sign Oxychem's less-than-honest reports to the California Regional Water Quality Control Board. He wrote:

> In the past I have sent a report monthly to the Water Quality Control Board which gives our discharge to the waste water leach pond. This report does not consider the chemicals leached from our gyp [gypsum] ponds and ditches or the chemicals discharged from Ag Chem. I don't believe the Water Quality Control Board is even aware that we process pesticides. Since this report isn't exactly accurate even though the inaccuracy is due to omission rather than outright falsehood, I don't really feel comfortable in signing it. However, I don't think it would be wise to explain the discrepancy to the state at this time.

Faced with this information, Oxychem finally agreed in late 1977 to authorize an abatement program. This program was based largely on construction of lined concentrator, cooling and waste-water ponds. No attempt, however, was made to prevent continuing percolation from previously dumped wastes, or to warn the state and owners of contaminated wells.

The state continued in ignorance until February, 1979, when an extensive testing program was mounted. High levels of several pesticides, including DBCP, malathion, methoxychlor, chlordane, ethyl parathion, ethylene dibromide, and DDT, were identified in a waste-water pond and ditch near the Lathrop plant. Local groundwater was also found to be contaminated with DBCP, ethyl parathion, and lindane. In one well, lindane concentrations of 22 ppb, fourfold in excess of the EPA safe drinking water criteria, were found.

Testing for DBCP and other possible contaminants in local wells led to some new discoveries. Norman Hixon, principal of the Lathrop elementary school, was one of the first local residents to find out about the new problem. Hixon received a call from the county health department, informing him that something had been found in the school

well water, something the county would tell him about at a meeting shortly. Hixon suspected that the county had found DBCP in the well, but at the meeting he was told the county had found elevated levels of radiation.

The levels of radiation found in the well were nine times higher than the EPA safe drinking water criteria. The water was immediately turned off, and a hookup to the uncontaminated municipal water system was established. While the school district took swift action to correct the problem, Hixon was miffed. "If we had been notified earlier, we would have had the water changed," he said, noting that the findings had been kept "secret."

The state alleges that radioactive water draining from Oxychem's fertilizer-manufacturing operation caused the contamination that closed the school well, a trailer-park well serving over eighty people, and about half a dozen other wells. Small amounts of radium and uranium in the phosphate rock used by the plant are considered the most likely sources of the radiation.

In March, 1979, the California Regional Water Quality Board issued a "cease and desist" order to prevent further discharge of wastes from the Lathrop plant. The order also established a five-month compliance schedule, during which the plant was required to submit a plan to determine the extent of pesticide contamination, to complete a survey of the plant site for pesticide contamination, to remove all contaminated soil to a secure landfill, to seal areas to prevent further groundwater contamination, to submit a report describing the real extent of groundwater pollution, and to recommend remedial action. On December 18, 1979, the federal government, together with the state of California, filed a civil suit against Oxychem, demanding $30 million in penalties and $15 million for cleanup. Additionally, a criminal investigation is now being conducted into the coverup.

On February 6, 1981, the federal government, the state of California, the Regional Water Quality Control Board, and the Occidental Chemical Company signed a settlement agreement that requires Occidental "to clean up contaminated groundwater and soil in the vicinity of the Occidental Chemical Company's facility." Details of Occidental's plan were still being worked out in the fall of 1981.

No firm estimates for the total cost of the cleanup work have been reported. However, the state of California estimated that the cleanup would cost around $16 million. Occidental disputes that figure. All parties agree that completion of the cleanup program will take from twenty to thirty years.

The settlement also required that Occidental pay the federal government $200,000 and the state of California $100,000 for the costs they incurred in investigating the problem. In addition, Occidental agreed to spend $1.5 million on groundwater research and pay the state of California's hazardous waste cleanup program $1 million.

The DBCP contamination and the radiation levels found in local wells have made the many Lathrop residents who depend on their private wells feel "insecure," says the Reverend Mr. Apolinar N. Sangaland. A retired clergyman, and thirteen-year resident of the area, Sangaland had been following the local events with great concern. "Quite a few people are upset about it," Sangaland says about the contamination problem, "especially the people employed by Oxy."

Both Sangaland and Hixon believe Oxychem should have been more careful. They also believe that if the state hadn't been looking for DBCP and other chemicals, people would never have known about the contamination. For Sangaland and Hixon, however, the only long-range solution is self-help. "I don't believe the government is going to take care of us," Hixon said. He pointed out that most area residents used their own well water and didn't have the money to get it tested on a frequent basis. Given the present circumstances, Hixon decided against drinking his well water. "I look at my own water and I'm not too far from the plant, and I can't afford to test it, so we're on bottled water now," he said.

The full extent of the groundwater pollution has not yet been defined. Based on the evidence developed so far, it seems that the pollution plume may move into residential areas north of the plant. Meanwhile, local area residents have the option of continuing to drink contaminated or untested well water or of buying bottled water.

Lathrop citizens remain nervous. "People have been trying to make a joke out of it," Hixon said. "They are selling T-shirts that say 'Lathrop, California -- It's the Water.'"

(from Epstein, S.S., Brown, L.O., Pope C. Hazardous Waste in America, Sierra Club Books, San Francisco, 1982, pp.75-81.)

Questions on the Lathrop, California Case

1. What kind of community is Lathrop? What is its main water source?

2. What substances caused contamination of the water and where were they generated?

3. How did the generator dispose of its waste? Why was Lathrop particularly prone to contamination from this method of disposal?

4. Was this practice legal? Why do you think the plant dumped pollutants into the lagoon? Why did they continue after Edison warned them?

5. Explain what you thought of Robert Edson's actions. What risks did he take? What risks did he not take?

6. How could he have acted differently? What risks would he have taken by acting out these other alternatives? If you had been in Mr. Edson's shoes, what would you have done?

7. How long did it take for the State to find out about Oxychem's toxic waste, and what does this tell us about the problems of enforcing toxic waste laws? What was the Federal Government's role in this case?

8. Once a toxic waste site is discovered, is the cleanup procedure done quickly? Explain. Did the citizens of Lathrop get any help?

9. What responsibility should Oxychem take for the pollution? Is it responsible for the impact on the community and/or the long-term health effects on Lathrop residents? Should Oxychem be responsible for compensating these people for damages? What was Oxychem held responsible for?

10. Some industries argue that they should be responsible for regulating themselves. Do you agree or disagree? What should the role of the government be in regulating industrial pollution? How should the government enforce these regulations?

11. How would you have described this case if you were: a manager of Oxychem, President of Occidental, the head of the Regional Water Quality Board of California, a worker in the plant, a resident of the community? How would each perspective differ?

12. If you lived in Lathrop, how would you feel and what would you do?

13. Research the profits Hooker Chemical Company (the parent company) or Occidental made in recent years. How significant of a fine did Occidental receive compared to its profits? Was this fine appropriate punishment for the legal violation?

Road Oil in Corrigan, Texas

On October 20, 1978, Ken Robinson, manager of Reily's Village, a small community in Corrigan, Texas, a hundred miles northwest of Nederland, awaited the arrival of road oil from Browning-Ferris Chemical Services Industries, Inc. (a BFI subsidiary)* [*BFI, a Houston-based corporation with assets of $415 million, is one of the state's largest haulers of waste oil and liquid and solid industrial wastes and describes itself as "the largest publicly-held company engaged primarily in the collection, processing, recovery, and disposal of solid and liquid wastes" in the nation. BFI has facilities in 135 towns in thirty-six states, employs some 8,000 people, and owns 3,200 "specially equipped collection trucks." In 1979, the company operated sixty-five solid-waste disposal landfill sites and disposed of liquid, chemical, and hazardous wastes at seventeen facilities, including six deep-injection wells, three "secure" hazardous waste sites, and four sanitary landfills. Although reputed by industry analysts to be most reliable, BFI has not been free of environmental problems, quite apart from road oil. In 1979 alone, BFI was a defendant in thirty-three proceedings for alleged violations of water, air, and land protection laws.]

Robinson, a private contractor who had been dealing with BFI since 1975, managed the spreading of road oil not only at Reily's Village, but also at Barlow Lake Estates and Town Bluff, two other southeastern Texas developments. Robinson used to keep in contact with BFI through Gene Davis, the operations manager of the company's transfer station at Nederland. Davis would let Robinson know when road oil was available. The road oil cost Robinson nothing. BFI not only gave it away, but also shipped it free of charge in its own tanker trucks.

When the truckloads of BFI road oil arrived at Reily's Village, Robinson cut a trench down the middle of each strip of dirt road and supervised the pouring of oil into the trench. He then mixed the dirt dug from the middle of the road back into the trench, "let it set," and then spread it evenly over the road. When the oiling was complete, Robinson signed a special Texas Department of Water Resources shipping manifest (trip) ticket, and the empty truck returned to Nederland.* [*Each load of hazardous waste transported in Texas must be recorded on such a manifest.] Between October 20 and November 13, 1978, approximately eighty thousand gallons of road oil were disposed of in this fashion.

As soon as the road oil was laid, the air filled with unpleasant fumes smelling like shoe polish. Ricky Goodson, whose home is within a hundred feet of one of the oiled roads, said the smell burned his nose and made his family sick. Eugene Fox, another area resident, said that the smell was so bad "you could hardly stand to be around it." Dozens of other residents in the Village and nearby Town Bluff Estates were sickened by the oil. "I've never had a headache in my life until six months ago. I would wake up in the mornings with a headache. Just terrible. Nauseous. Sick to my stomach," said George Barber.

Animals in the area were affected too. Robert Duff reported that he

had lost several dogs since the oiling. He complained that "patches of hair" had come off one of his dogs which had to be destroyed. Douglas Wilder had worse luck. Soon after the road outside his farm was oiled, six calves and three cows in nearby pastures died from "apparent poisoning."

DISCOVERY OF THE CONTAMINATION

In spite of these problems, nobody complained to the local authorities. The offensive smell was just accepted as an unpleasant fact of life. Then, on April 26, 1979, Jim Carlton of the local Port Arthur News reported that the road oil used in Corrigan was contaminated with heavy concentrations of nitrobenzene and trace amounts of cyanide.

While reviewing the BFI file in the Orange office of the Texas Department of Water Resources, the state agency in charge of waste disposal, Carlton came across a complaint from Melvin Grizzard, previous manager and chemist in charge of the storage tanks at BFI's Nederland plant. On November 2, 1978, Grizzard had informed the Jefferson County pollution control agent, Victor Bateman, that the road oil shipped to Corrigan was probably contaminated with cyanide. Grizzard said that he had been ordered by the plant operations manager, Gene Davis, to prepare a batch of road oil by mixing waste oil with cyanide-containing wastes obtained from the giant DuPont chemical complex in Orange.* [*DuPont appears to have assumed implicitly that its waste would be properly disposed of by BFI and its subcontractors.] Grizzard insists that when he objected, Davis told him, "Don't worry about it, Mel. We've been doing it for years." Grizzard was so upset that he called Nederland's manager, Steven Custer, at home around 2:30 a.m. that night. Custer told Grizzard to meet him at the office the next morning. When Grizzard arrived, he was told he had been fired.

Bateman immediately referred Grizzard's complaint to the Texas Department of Water Resources, which sent an inspector, Melvin Swoboda, to examine BFI's records. Swoboda found trip tickets showing that the cyanide wastes from DuPont had been shipped by BFI to Sonics, Inc., a deep-well injection operation in Ranger, Texas.* [*In deep-well injection, liquid wastes are pumped hundreds of feet under the ground, below known water tables.] The incoming and outgoing trip tickets for the cyanide wastes hauled by BFI balanced perfectly. Swoboda also checked Grizzard's unofficial records on tank contents and volumes and found that they also balanced with the trip-ticket information. As far as Swoboda could tell, all the cyanide waste seemed accounted for, so none could have been used in the road oil. However, his investigation covered only trip tickets for cyanide shipments over the preceding two months. Swoboda failed to check whether the cyanide had been received by Conservation Services and Sonics, to test the road oil being shipped to Corrigan to see if it was contaminated, and to test the oiled road surface. Furthermore, Swoboda restricted his inquiry to the possibility of cyanide contamination and did not investigate the possibility of contamination of the road oil with any other toxic waste.

Carlton was not impressed by Swoboda's perfunctory investigation of

the complaint and decided to take matters further. He and other newspapermen and government officials visiting Reily's Village some five months after the roads had been oiled found that the fumes made them sick and nauseated, even though the shoe-polish-like odor had by then largely dissipated. Inquiries at BFI made it clear that no adequate records were kept on the quantities and types of wastes being received, stored, and shipped, where they were shipped, or their ultimate disposal site.

Analysis by the state of Texas of samples from the surfaces of various dirt roads in Corrigan revealed low levels of cyanide, but very high concentrations of nitrobenzene, another toxic waste stored at the Nederland BFI facility.+ [+An estimated 400 million pounds of nitrobenzene are manufactured each year for use in soap, perfume, cleaners for wood, wood flooring and paneling, and as an ingredient in metal and shoe polishes. Nitrobenzene is relatively persistent and its liquid and vapor penetrates the skin rapidly. Vapor absorption by inhalation is high. Nitrobenzene is moderately toxic, and induces hemolytic anemia, hepatitis and jaundice, central nervous system damage, and skin disorders.] The state confirmed these results in eight separate areas of eastern Texas, where about nine hundred thousand gallons of BFI road oil had been spread between 1976 and 1979. Nitrobenzene concentrations in dirt on these roads ran as high as 21,000 ppm, with the highest levels in Reily's Village.

THE CONGRESSIONAL INVESTIGATION

In May, 1979, in preparation for hearings on hazardous wastes, Congressman Bob Eckhardt, then chairman of the House Commerce Subcommittee on Oversight and Investigations, sent a small team of investigators to examine the operations and records of the BFI Nederland facility. The investigators concluded that BFI had been "grossly negligent" in its handling of hazardous wastes.

While not charging BFI with deliberate intent to "dump" hazardous wastes on east Texas roads, Eckhardt released a staff study that showed that getting rid of nitrobenzene in road oil was far more profitable than proper disposal of the hazardous waste. Shipping the nitrobenzene waste to Conservation Services' landfill would cost BFI $526 per load. If the waste were shipped to Sonics, a deep-well injection operation, BFI would realize a profit of $291 per load. On the other hand, if BFI simply dumped the nitrobenzene waste on Corrigan roads, it could realize a profit of $1,087 per load. BFI objected to this analysis at the hearings, but never subsequently provided contrary documentation.

BFI accepted full responsibility for "the serious, unfortunate incident whereby the processing of certain nitrobenzene waste streams at the company's Nederland, Texas facility resulted in contamination of waste oil..." and agreed to undertake the large-scale removal of contaminated soil from the miles of oiled roads atr a cost of about $3.3 million. However, BFI claimed that the contamination had been due to an unfortunate accident:

"The company's investigation has not uncovered any credible

information that would lead to the conclusion that nitro-benzene or other hazardous substances were intentionally mixed with waste oil in order to dispose of such hazardous substances as road oil. However, improper and careless practices by company personnel in their handling of these materials unintentionally brought about this regrettable occurrence."

The Corrigan roads "accident" was not unique in BFI's operations. For instance, while BFI claimed to have shipped six truckloads of cyanide wastes to Sonics and had billed DuPont for six, only four had, in fact, been received by Sonics. BFI also claimed to have shipped about 218,000 gallons of nitrobenzene to Sonics, but, when questioned, BFI retracted its statement, saying that the shipment in question had been another industrial waste. Attempts to balance the incoming and outgoing cyanide-waste ledgers resulted in a shortfall of 75,000 gallons. BFI claimed that the "missing" cyanide was in storage, to be later shipped for disposal to an unspecified site, but produced no supporting documentation.

(from Epstein, S.S.; Brown, L.O.; Pope, C., Hazardous Waste in America, Sierra Club Books, San Francisco, 1982, pp. 140-145.)

Questions on the Corrigan, Texas, Case History

1. What was the cause of the contamination in Corrigan? What were the effects of the waste disposal?

2. Who should be held accountable for this contamination, the generator, BFI, the transporter, or Ken Robinson, the disposer?

3. Who discovered the toxic waste, and what action was taken? Why hadn't the community complained?

4. How was Grizzard's response different from that of Robert Edson in the last case history? What was the consequence of Grizzard's action? Do you think he would have written to the Department of Water Resources if he had not been fired? Did Grizzard take enough action on this case? Explain. If you had been Grizzard, what would you have done?

5. Why was no action taken on Grizzard's report? Who should be given the credit for proper action? Was this done?

6. What was BFI's motivation for the dangerous disposal of the toxic waste?

7. How would you describe the case if you were: the President of BFI, Ken Robinson, DuPont's President, Jim Carlton, Reily's Village residents, Melvin Grizzard, Melvin Swoboda, or Bob Eckhardt. How do their perspectives differ?

8. This unfortunate incident happened in Corrigan despite the fact that Texas has good toxic waste laws. There are, however, loopholes in these laws. What other steps can be taken to prevent such toxic waste dumping?

STUDENT ACTIVITY 1

What is a Hazardous Waste Substance?

Almost every day one can find articles in the newspaper about the political, economic, and environmental aspects of toxic waste. Words like "dioxin" and "PCB" are showing up all the time. What are these substances? Where do they come from? What other substances are classified as toxic waste? The following activities and reading material will help you answer these questions.

A toxic or hazardous waste substance is any solid, liquid, or gas that, if disposed of incorrectly, potentially can endanger the health of individuals or harm the environment. Although most toxic waste is generated by industry, some of it comes from such sources as town dumps.

The purpose of this activity is to find out what hazardous substances are found in your own home. Using the above definition, search your home (particularly the kitchen, laundry room, basement, and garage) and make a list of all those substances that you think could be a possible toxic substance WHEN DISCARDED. Remember, this category need not include any substance that would be poisonous if ingested directly (e.g. a whole bottle of medicine). You will bring this list to class and compare it with those of your classmates.

Student Reading on Hazardous Waste

The Environmental Protection Agency has identified more than two hundred substances that are potentially harmful to living organisms or to the environment, and more toxic material is being discovered all the time.

There are many different types of toxic wastes: flammable substances, corrosives, heavy metals and asbestos, synthetic organic compounds, infectious material, and radioactive substances. Although the disposal of radioactive substances is a huge problem, it is regulated by separate laws and will not be discussed here.

Flammable toxic wastes are those substances such as sodium or petroleum that can explode spontaneously when mixed with oxygen. The corrosive category consists of substances like acids and bases. If stored incorrectly, these can erode their containers and get into the soil. Animals and humans can receive severe burns if they are in contact with these substances. In addition, when released, they can alter the pH of soil and water and, therefore, kill plant and aquatic life. They also react with minerals in the soil, releasing heavy metals such as lead, aluminum, and mercury, which can harm organisms further.

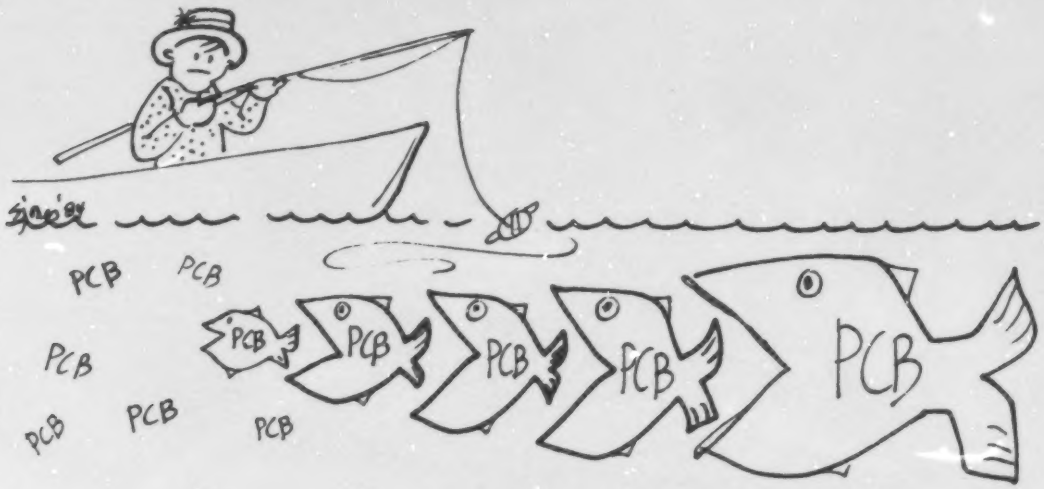
The most toxic of the heavy metals are lead, arsenic, cadmium, and mercury. Zinc, though not dangerous by itself, is classified as a toxic metal because often it is mixed with small amounts of cadmium and lead. Some substances in which lead can be found are gasoline, storage batteries, and paint. When ingested, lead affects many organs in the body, but particularly the nervous system, causing brain damage in children. Severe lead poisoning can be fatal. Arsenic is present in many agricultural products. It causes slow cell death and can cause symptoms like loss of weight and gastro-intestinal problems. Cadmium is found in pipes and tires, and is thought to be involved in heart disease and cancer. Mercury is used in paints and seeds as a fungicide, in the chemical production of chlorine, and in batteries. Its primary effect is on the nervous system. Zinc is used to galvanize iron and also is used frequently in batteries.

Asbestos is made from several minerals and is used to resist flammability. It can be found in brake linings, insulation, and formerly was present in scientific laboratories. When its fibers are inhaled, it is very carcinogenic.

Because they are elements, heavy metals are nonbiodegradable and will not disappear when heated. They can react with other substances to form nontoxic substances. They, therefore, are a persistent problem when free in the soil.

Synthetic organic compounds are substances formed from naturally existing hydrocarbons such as coal, methane, or petroleum. Synthetic hydrocarbons such as ethylene, toluene, and benzene are used as industrial solvents and are carcinogenic. By combining hydrocarbons with halogens such as chlorine or bromine, chemists have produced pesticides

such as DDT and substances like PCB and dioxin which are found in insulators and herbicides respectively. Many of these substances are known to be carcinogenic and cause birth defects. They are all relatively nonbiodegradable. Although this quality is desired for their industrial uses, it means that when discarded, they remain in the environment for a long time. They are also bioaccumulative; that is, they become soluble in the fat tissue of living organisms, and, as one organism is eaten by another, the amount of toxicity increases. Heavy metals are also bioaccumulative. For this reason, large fish such as swordfish and bluefish are prone to contain unhealthy amounts of such chemicals, and are frequently taken off the market.



The infectious group of substances is discarded from laboratories or hospitals and consists of clothing or other materials carrying disease-bearing organisms.

The EPA estimated that in 1980 approximately 57 million metric tons of these toxic wastes were produced by industry alone and the amount increases each year. Ninety percent of this material is disposed of incorrectly in 30-50,000 hazardous waste sites. Improperly built landfills will cause leakage of toxic wastes into groundwater or runoff from the surface of the site. Water sources can become contaminated. Accidents such as fires or explosions can also release the toxic substances.

Though many companies are very conscientious and innovative about their waste treatment, according to Samuel Epstein, author of Hazardous Waste in America, much of the toxic waste dumping is done illegally or without forethought. Many sites are found in rural, sparsely populated areas where companies buy land cheaply and drop wastes without being seen. As these areas become more populated, their water supply (usually from private wells) is apt to be polluted. In addition, animals and children wandering around the sites can be hurt by contacting the material directly.

TYPE	SUBSTANCE	POSSIBLE EFFECTS
Flammable	Sodium Petroleum	Explosion when exposed to oxygen
Corrosive	Acids Bases	Severe burns, damage to plant and animal life, release of heavy metals when in the soil
Heavy metals	Lead Arsenic Cadmium Mercury Zinc	Poisoning, damage to the nervous system, brain damage
Synthetic organic compounds	Industrial solvents Pesticides Insulators Herbicides	Cancer, birth defects
Infectious material	Material carrying disease-bearing organisms from labs and hospitals	Infectious diseases
Radioactive substances	Radium Uranium Plutonium	Cancer, birth defects, radiation sickness

In order to avoid the cost of proper disposal, some companies do "midnight dumping;" that is, they drop containers of toxic waste off trucks, abandon loaded trucks, mix toxic and nontoxic substances and leave them at town dumps, etc. There is some evidence that organized crime is involved in this dumping. Another common procedure for dumping of excess oil used to be to spread it on dusty roads in rural areas. This oil contained heavy metals, detergents, and some carcinogens and was sometimes mixed with still other hazardous material.

What can be done about this huge problem? The answer is really two-fold. First, the areas that are already contaminated need to be cleaned up. Second, ways of reducing the amount of new toxic waste and improving methods of treatment must be found. To help with the cleanup, the 1980 Congress passed a bill known as the "Superfund." This bill provides $1.6 billion to help pay for cleanup not covered by other laws. The money from this program is raised largely through taxing industry, but the government can also sue the companies directly responsible for the problem. The law does not pay for personal damages and does not provide enough money to pay for all the cleanup already necessary.

The government has also established laws to regulate the future disposal of toxic wastes, the most important of which is the Resource

Conservation and Recovery Act (RCRA) of 1976. This law requires the EPA to identify toxic wastes, set standards for proper disposal and treatment of the material, and check its storage, transport, and disposal. Generators and transporters must have an EPA permit to operate, and must sign certain forms each time the waste is moved. Failure to comply with the law can result in criminal proceedings. Other laws such as the Safe Drinking Water Act and the Clean Water Act also deal with regulations for and cleanup of hazardous substances.

The problem of toxic waste is increasing. Because it is an issue that confronts many different interest groups, the search for satisfactory solutions is complicated. Though most people would agree that reducing pollution is important, they disagree on how much to pay and who should pay for improving the situation. "The Environment" is one of the major issues of the 1980's. Find out what local, state, and national candidates are saying about this issue. Who do they believe should be primarily responsible for environmental quality — individuals, industry, state government, or federal government? Are they committed to supporting or suggesting new proposals? Are they committed to more federal spending? Discuss these questions with parents, teachers, and friends. After completing this unit, formulate your own ideas about possible solutions. Perhaps you can even write to your congresspersons to ask about their stand and to give them your opinion.

(from Parade Publications, N.Y., July 1, 1984)

STUDENT ACTIVITY 2

Finding Out More about Residential Toxic Waste

The purpose of this activity is to find out whether people are aware of toxic substances in their homes and how such substances are discarded.

Now that you are more knowledgeable about the subject, do a new home toxic waste survey. Show the list of toxic substances that was compiled by your class to your parents and ask them how they dispose of those substances. Take the list to at least five homes in your neighborhood. Tell your neighbor that you are doing a toxic waste survey for school. After defining toxic waste for them and showing them your list, ask them to answer the following questions:

1. How many substances on the list did you realize could be hazardous?

2. What do you usually do with substances like these in your home?

   a. Throw them in the trash.

   b. Take them to the local dump.

   c. Take them to toxic waste collection sites.

   d. Keep them because you do not know how they should be discarded.

After completing your survey, answer the following questions:

1. Did your neighbors seem well-informed about toxic waste?

2. How were toxic wastes most often disposed of?

3. What was their attitude toward the survey?

4. How did you feel while doing the survey? Explain.

Compare your survey with those of your classmates. Now make a generalized statement about how home toxic substances are usually discarded.

As a follow-up, survey the teachers in the science department to find out how they dispose of toxic substances used in the lab. What kinds of safeguards do they employ? What toxic substances are disposed of? Where do they end up?

A Reading for Students on Hazardous Waste Treatment

The following reading discusses different ways in which toxic waste can be treated or properly disposed of. If not taken care of by one of these methods, the material often becomes a leachate (the solution containing toxic substances) which then contaminates groundwater.

Almost half of the United States' water supply comes from groundwater, and in some communities, particularly rural ones, the population is almost totally dependent on it. Groundwater is also formed by precipitation percolating through the soil into the rock layers below. There, it fills any available spaces and flows through cracks. Groundwater can end up miles from where it was formed. Sometimes groundwater feeds lakes and rivers, and sometimes, these bodies of water feed groundwater. Therefore, contamination of groundwater, rivers, lakes, or marshes can eventually pollute the water supply.

When reading about the available methods of treatment, consider the following estimates on the cost of new treatment facilities (1979 statistics):

Physical/Chemical/Biological Treatment	$2-5 million
Incineration	$10-20 million
Secure Landfill	$2-5 million
Deep-well Injection	$2-3 million

(from National Solid Wastes Management Assn.)

After completing the reading material, answer the following questions:

1. What are the drawbacks of each method?

2. What are the advantages of each method?

3. Would you be willing to have any of the treatment facilities in your community? Why?

4. Would you be willing to live next to any of the treatment facilities? Why?

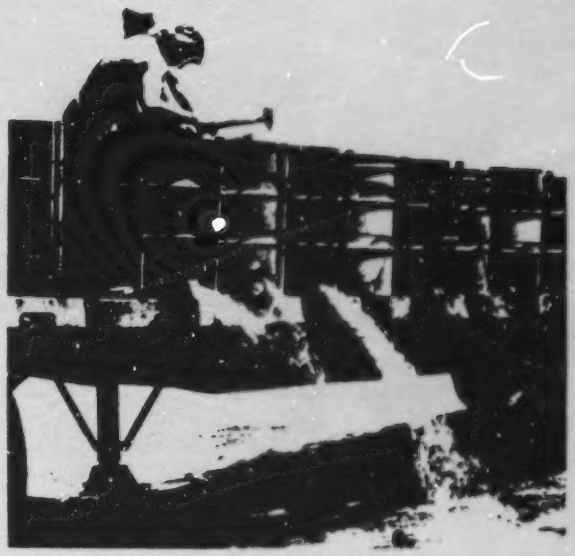
From: Hazardous Waste: A Community Action Guide. Concern, Inc., Washington, D.C., 1981, pp.7-9.

Technology

In 1980, of the total amount of waste produced in the U.S., 57 million metric tons were classified as hazardous. Ninety percent of this was handled improperly. Often these wastes were simply placed in containers and stored in warehouses. This storage stage may last months, years, or decades while a safe disposal method is sought and approved.

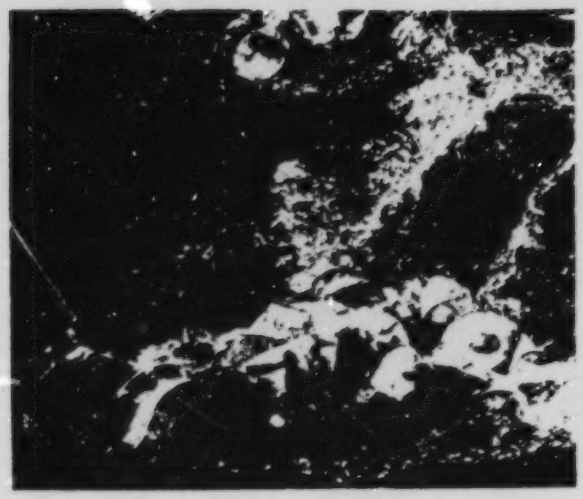
In the past, half of all wastes were placed in ponds, lagoons, or impoundments — most unlined and, therefore, a continuous threat to underground water supplies. Another 30 percent were put in unsafe or nonsecure landfills, and another 10 percent were incinerated with little air pollution control. Slowly this gloomy picture is changing. Industry, beginning to recognize the extent of the problem, is taking some initiatives in better disposal practices. Improved technology and increased government regulation through the Resource Conservation and Recovery Act of 1976 should help control and monitor hazardous waste management.

Several alternatives are available for the reduction in volume and disposal of hazardous wastes:



Reduction of Waste Volume

- *Changing industrial processes.* These methods use production and processing systems which generate less hazardous waste or develop new products without toxic wastes. This is an expensive but desirable route. With the expected increase in disposal costs, lowered production of hazardous waste will undoubtedly result.
- *Selling the wastes.* About 20 waste exchanges exist in the United States, either as information exchanges where buyer and seller are put into contact with each other or as actual materials exchanges. In Europe, trades of as much as 30 percent of listed wastes have resulted. In the United States, the rate is only 20 percent. This figure is expected to increase as new exchanges are established.
- *Treating the wastes.* Neutralization, oxidation, and biodegradation are some of the processes used to render hazardous waste less toxic or harmless.
- *Recycling the wastes.* Many wastes can be reused in the industrial process by the generator or by another manufacturer.



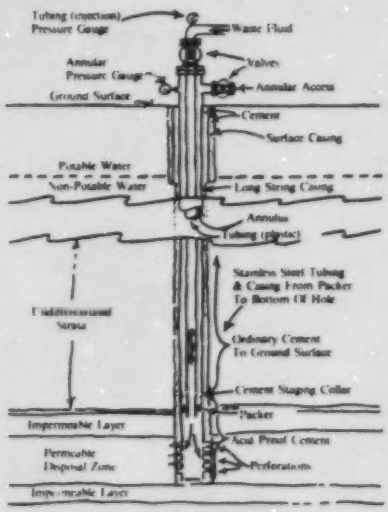
Deep Well Injection

Injecting hazardous waste into deep wells is one of the most controversial methods of disposal. Liquid hazardous waste is forced under pressure down a well, built with shafts of stainless steel and concrete casings, into porous rock which has an impervious layer of rock above as well as below the disposal zone. The area must be below ground water level. The ground water is protected by the layer of rock and by the cap that is put in place after the well is full. Safety is maintained by precision engineering, constant monitoring of the pressure, and inspections by government personnel. Wells closest to ground water supplies are required to be strictly monitored. It is estimated that three to five percent of hazardous wastes are disposed of in deep wells, and that approximately 20 new wells will be added per year.

Proponents argue that this method is safe and cheap; opponents say it is shortsighted and dangerous. EPA policy has opposed deep-well injection unless extensive hydrological and geological studies assure that ground water will not be contaminated and unless the alternatives pose even worse environmental dangers.

High Temperature Incineration

When air pollution standards are met, incineration can be the safest and cleanest way to dispose of hazardous waste. It is also expensive. * Incinerators burn both solid and liquid chemical wastes at temperatures ranging from 1100° to 2200° F. This method solves a number of environmental and disposal problems: it reduces the volume of the waste; it can be used as an energy recovery technique; and it is a way of detoxifying certain materials. EPA currently requires up to 99.99 percent destruction of hazardous wastes during incineration. Some waste will remain as either toxic or nontoxic ash. Only 15 hazardous waste incinerators existed in the U.S. in 1979, six of them operated by disposal companies, the others by manufacturers who generated the wastes. Because of more efficient monitoring, less residue, and improved technology, incineration may be a viable alternative among hazardous waste disposal methods. We may expect increased demand for this technology as government environmental regulations are enforced.



TYPICAL DEEP INJECTION WELL

Credit: Texas Environmental Coalition

* Burning wastes at sea is being explored as one of the ways to decrease the high cost of incineration. To date, there are two operating incinerator ships. Because these ships are not required to have scrubbers to clean the flue gases, incineration at sea is less expensive than land-based incineration.

Disposal of Wastes

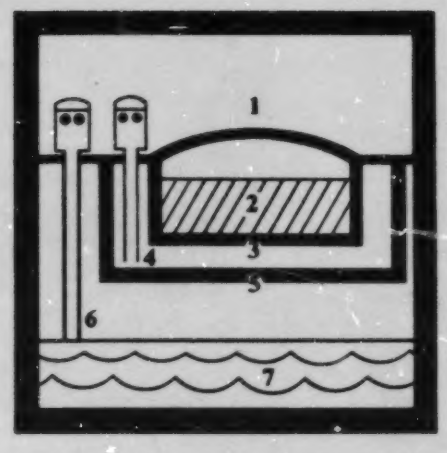
Available methods for the disposal of hazardous waste include dumping it in properly managed surface impoundments, lagoons, and landfills; injecting it into deep wells; and incinerating it at high temperatures. Proper management of each of these disposal techniques is *crucial.*

Surface Impoundments and Lagoons

When properly lined and managed, surface impoundments and lagoons help reduce the quantity of hazardous wastes through evaporation. They are dangerous, however, when rainfall exceeds evaporation and causes them to overflow.

Landfills

Traditionally landfills have been the most common means of disposing of hazardous waste because they were inexpensive and used simple technology. When poorly constructed, or disturbed by natural or human activity, their contents leached into the water and also escaped as gases into the air.



Protective areas of a secure landfill include: 1) clay cap; 2) waste; 3) inner-liner; 4) seepage collection system; 5) outer-liner; 6) monitoring well; and 7) underlying groundwater.

Do landfills in your community fit this description? Contact your state representative to determine whose responsibility these landfills are.

In 1980, federal regulations set specific standards for the construction and operation of "secure" landfills: that they be located in safe geological areas, at a specified distance from a water source, lined with enough clay or synthetic material to prevent leaching, and ultimately sealed with another layer of clay. Monitoring surrounding land and ground water is required during the operation of the landfill and for 30 years after its closure.*

*Pending further EPA study, all liquid disposal is barred from landfill sites.

STUDENT ACTIVITY 3

Exploring How Toxic Waste is Treated in Your Community

From your survey on home toxic wastes, you probably discovered that most people send their hazardous material along with the rest of their trash to the local landfill. You will now explore the possible options for disposal in the area where you live.

Your first step is to make several phone calls to find out the following information:

1. What are the number, location, and types of disposal facilities in the surrounding area? Are there old facilities or landfills that are now closed?

2. Are any new sites going to be built soon?

3. Who is responsible for overseeing these facilities?

4. What criteria are used to determine the placement of the facilities?

5. How many years does it usually take to fill up a landfill in this community?

6. What companies in the area produce toxic waste? Where and how do they dispose of this waste?

7. How are harmful levels of pollutants determined?

8. What tests of the local groundwater are done? How often? What tests are not done?

The following list should give you a starting point for your search:

the local Sanitation Department

the local Board of Health

the state Department of Waste Management

the state division of the EPA

the local chapter of the League of Women Voters

the local consumer protection agency

local industries

city officials, state representatives, Congresspersons and cndidates seeking office

You may want to ask representatives to come to your class to discuss

waste disposal in your community, its regulation, enforcement and any plans for future sites or facilities.

Based on your findings, your class will choose one or more landfills to investigation further. The landfill you investigate may be one that is an old one and no longer in use. Read the following material and reread the landfill section of the treatment readings. Then you either will visit a landfill or continue interviewing on the phone. Using the information from the reading material, create a questionnaire that can be used in your investigation.

At the end of your study, using the standards suggested in your reading, you will determine whether your data indicates that the facility is safe or not. Remember that you and your classmates are not experts, and that further investigation would need to be done to support your findings. Who should be contacted to do such studies?

Criteria for Landfills

1. To protect groundwater, the landfill should be no less than 5 feet above the underground water level, and in sandy areas, should be no less than 10 feet above the water table.

2. Sites should not be built around groundwater areas that directly feed a public water supply.

3. Sites should not be built where there could be runoff into surface waters such as streams or marshes (areas like flood plains should not be used).

4. All sites should have an 18 inch thick liner made of clay soil or an impermeable material such as plastic.

5. Rain should drain away from the site and should not form sitting pools that could dissolve toxic substances.

6. Sites should monitor surrounding groundwater.

7. Incompatible wastes should be separated to prevent chemical reactions.

(Adapted from: Epstein, S., Brown, L. and Pope, C. Hazardous Waste in America. Sierra Club Books, San Francisco, 1982, p.434.)

TEACHER'S INTRODUCTION TO LAB ACTIVITIES

The following group of activities are intended to show students how hazardous substances are detected and tested. Although many chemicals are testable, because of the simplicity of the tests, we have chosen as indicators salt and chloride content and pH. It is important that students realize that different environments may show natural variations of these substances, and, therefore, that their presence does not automatically mean pollution. This problem can be explored in a class discussion of the questions which accompany each activity.

A second goal of these experiments is to have students examine the scientific quality of an experimental design and be able to suggest improvements. They should look for a control, a large sample, a sample that is compatible with the purpose of the experiment, and variables other than the one being tested that could effect the experimental outcome. A post-lab discussion of experimental data and the questions is essential to promote understanding of these factors.

The first activity can be used in conjunction with the exploration of the local landfill. In preparation for this lab, a second, more detailed discussion of groundwater is included. The experiment will demonstrate that water does not readily percolate through clay, but does through sand; therefore, landfills should be built on a clay surface. In order not to influence student answers, the article on the problems of groundwater testing should be read after the second activity is completed.

Teacher's Answers for the Lab Activity Questions

Lab Activity 1:

The answers will differ depending on the type of clay soil and sand used. In our study the flow rate for sand was approximately 50cm^3/min. and for the clay soil was 50cm^3/11 min. The color began to leach rapidly in both samples, but was washed out faster from the sand than the clay.

Clay is better than sand at retaining toxic wastes because water does not penetrate through it as readily.

Lab Activity 2:

Again results will differ greatly depending on the sample taken.

1. Distilled water is necessary as a normal control base with pH 7 and 0 salt content.

2. The dropper should be rinsed with distilled water so samples are not contaminated.

3. The patterns depend on samples, but areas such as those near roads should show a higher chloride content due to road salting and possibly a lower pH because of car emissions.

4. No, there are natural variations in soil and water.

5. No, the tests were not delicate enough to rule out contamination, not enough samples were taken, and the areas could be contaminated with substances that were not tested.

6. Natural variations in these factors occur because of mineral deposits and types of vegetation (e.g. pine needles make soil acidic). Also fertilizers and lime may have been spread in the areas.

7. The regional Department of Environmental Quality or Solid Waste Management, local Department of Public Health, etc.

Activity 3:

Data will differ depending on the concentration of organisms in the original inoculate. In our study, Euglena survived best in 0% salt and pH 5.

1. To see a larger sample and to see if there was any experimental error.

2. Using the solutions with pH and salt concentrations as in the above chart, [NaCl] > .5% and 3 < pH > 9.

3. No, different organisms may respond differently (e.g. fresh water vs. salt water fish).

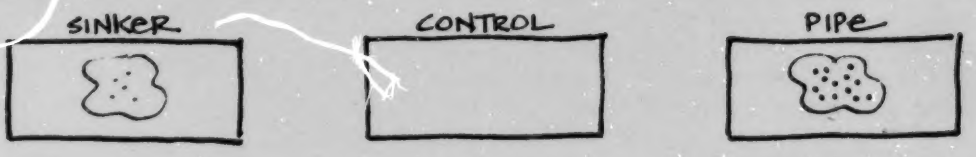
4. Try the same experiment using different organisms.

5. Accept all student ideas.

6. Provide material from the EPA or have students contact EPA offices directly.

Activity 4:

1.



2. There are white-ish deposits left from the sinker and pipe drops but not from the distilled water. Crystal formation may be apparent.

3. For a control.

4. From contaminated water supplies or by dissolving from pipes.

STUDENTS' READING FOR LAB ACTIVITY 1

Toxic Waste and Groundwater

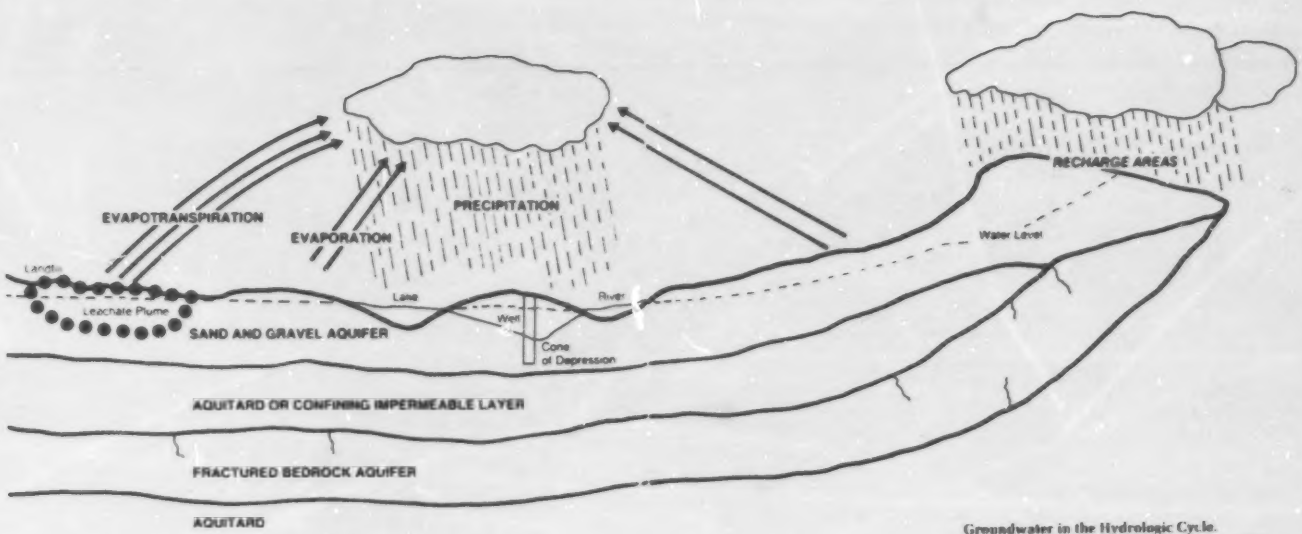
One of the major dangers of improper disposal or accidental spillage of toxic waste is groundwater contamination. Groundwater is under the surface of most of the country in aquifers, underground areas that can release water to springs or wells. There are two types of aquifers. One is relatively superficial and is found in layers of sand and gravel. Water generally flows slowly through these aquifers in the same direction as local rivers and streams. The second kind is in bedrock. Here the water flows through cracks and fissures as underground streams until it surfaces as a spring.

Many substances are soluble in water. Thus, all natural water supplies contain some dissolved material. Most of these substances, such as calcium or limestone, are harmless. However, many toxic substances can also be dissolved in water and will be added to the groundwater when rain percolates through the soil. Possible contamination of groundwater comes from town landfills, industrial waste sites, application of road salt, agricultural chemicals and pesticides, and accidental spills (such as leaks from old gasoline tanks).

Many town landfill sites were not chosen with these facts in mind. The contaminated water under landfills can flow several thousand feet in all directions from the landfill site. Furthermore, well pumping draws groundwater or stream or river water into well areas to replace the water being pumped out. If these sources are contaminated, then the water supply will become contaminated. Wells that supply the public are routinely tested for many substances, although new contaminants may go unnoticed. In private wells, which are rarely tested, contamination is discovered through bad odors, discoloration of vegetation, and health problems of animals and humans.

What can be done to prevent further groundwater contamination? First, less toxic waste needs to be buried than is now. Much of it can be treated and may be recycled as useful substances (e.g. motor oil). Other substances can be incinerated and used to produce electricity. Finally, landfills should be built away from streams, wet lands, and aquifers, and should be contained by impermeable layers through which water does not pass readily. The purpose of the following lab is to compare the flow of water through sand and clay to determine which would be a better material on which to build a landfill.

(From Aquasphere, Journal of the New England Aquarium, Boston, 1984, 18:26-27.)



Groundwater in the Hydrologic Cycle.
(Adapted from figure used in U.S. EPA., 1977)

STUDENTS' LAB ACTIVITY 1 WORKSHEET

A Comparison of Water Flow through Sand and Clay

The purpose of this experiment is to demonstrate whether clay of sand would be a better material on which to build a landfill.

Materials:

fiberglass	clay-rich subsoil
2 funnels	red food coloring
sand	2 250 ml Erlenmeyer flasks

If sand and clay are not readily available in the soil in your area, check with your art department or artist supply outlet.

Procedure:

1. Put a fiberglass plug in the bottom of two funnels. Be careful handling the fiberglass. It can be an irritant.

2. Label one funnel "sand", and fill it with damp sand.

3. Label the other "clay", and fill it with a clay rich subsoil.

4. Place each funnel in a 100 ml breaker.

5. Put 2 drops of food coloring on the soil in both funnels.

6. Be prepared to time this experiment starting when you begin to pour water into the sand and clay and noting: 1) When the colored water appears in each flask, and 2) How long it takes to collect 50 ml of water. Read the questions in the result section so that you can time your experiment correctly.

7. Note the time and slowly pour water on the soils. As the surface dries, add more water. When 50 ml of leachate (the liquid leaching through the sand or clay) has been collected, switch beakers and continue to collect it until the color is completely washed out.

Results:

1. How long does it take for color to appear from the sandy soil? from the clay soil?

2. How long does it take to collect 50 ml of leachate from the sand? from the clay? Calculate the rate of flow in cm^3/min.

3. How much water is needed to completely wash out the color from the sand? from the clay?

Discussion:

Compare your results with those of your classmates, and explain how the results justify the recommendation that landfills be built on clay.

TEACHER'S INTRODUCTION TO LAB ACTIVITY 2

Testing Soil and Water

Students should be supplied with several small bottles, preferably plastic, with covers or caps and instructed to collect samples from surrounding streams, ponds, marshes, roadside soil, other land areas, etc. Samples should be carefully labelled and brought back to the lab where they can be tested. Collections can be made during class time or as a homework assignment.

Because of small variations in pH, it is necessary to use Universal pH Indicator Paper instead of Litmus Paper. The presence of chloride is shown when a white precipitate is formed after the addition of 1M silver nitrate to a sample. Because of the minute amount of chloride in the students' samples, any cloudiness should be considered a positive result. The degree of cloudiness could be ranked, if so desired (+++, ++, +). Much more quantitative testing can be done with water pollution kits available from biological and chemical supply companies, such as Wards or Carolina.

An extension of this activity is to map the tested area. Detailed maps of towns and cities are usually available from local officials. By doing such a mapping, students might be able to predict from where pollutants are coming.

After completing the experiment and the reading, have students compare the detectable and acceptable levels of other chemicals from the two tables provided. For example, the detectable level of benzene is 1 µg/1 whereas the acceptable level is only 0.65 µg/1. Ask them what these figures imply about testing procedures.

STUDENTS' LAB ACTIVITY 2 WORKSHEET

Testing Soil and Water

One of the many indicators of hazardous waste are abnormal pH and chloride content. The purpose of this experiment is to see if you can identify any local areas that are potential toxic waste sites. Because of car emissions and winter salting, roadside areas are particularly susceptible to pollution.

Materials:

7 clean test tubes	pH paper
labels	silver nitrate solution
test tube rack	medicine dropper
distilled water	7 bottles with covers or caps

Procedure:

1. Obtain 6 clean stoppered bottles.

2. Locate 3 different sources of water (ponds, marshes, streams, etc.), and put a sample of each in your first three bottles.

3. Carefully label each bottle with the location of your sample.

4. Locate 3 different locations from which to take soil samples (roadside, meadow, near a stream, forest, etc.). Fill the remaining bottles about 1/4 full and label each carefully.

5. Bring all 6 bottles back to the lab.

6. Add distilled water to your soil samples and shake. Allow the contents to settle.

7. Obtain a bottle of distilled water.

8. Test the liquid in each of the 7 bottles with pH paper, and record your results in the chart below.

9. Take 7 clean test tubes. Label them according to your original set of bottles. Add a dropperful of each sample of liquid to the corresponding test tube. Make sure you rinse the dropper in distilled water between samples.

10. Add 5 drops of silver nitrate to these test tubes and look for any clouding of your solution (clouding or a white precipitate indicates the presence of chloride). Be careful in using silver nitrate, it is poisonous and stains skin and clothing. Record your results.

Results:

Location of Sample	pH	Chloride (+ or -)
Distilled water		

Discussion:

1. Why was the test tube of distilled water included in this experiment?

2. Why was it necessary to rinse your dropper with distilled water?

3. Compare your results with those of your classmates. Do you see any patterns showing how pH and salt content differ in different areas? Explain.

4. Do any of your results determine conclusively that an area is a potential hazard? Explain.

5. If any of your results were negative, could you conclude that the area was uncontaminated? Why?

6. What other factors besides toxic substances could alter pH and salt content in these areas?

7. If you and your classmates did discover a potential toxic waste site, whom should you contact?

Student Reading on Testing Drinking Water

TESTING DRINKING WATER -- What Do You Look For? (From Everyone's Backyard. Citizen's Clearing House for Hazardous Wastes, Inc. Vol. 2.2, p.8, 1984.)

You believe there may be toxic chemicals in your drinking water. The water tastes funny and your boiled potatoes turn an odd shade of grey. You ask the government to test the water, but they refuse. Now what can you do?

How to get your water tested for chemical contamination is unfortunately becoming an increasingly common problem. How do you go about it? Who should do the testing? What do you look for? Here's some advice, based on our experience.

How do you go about having your water tested? How should you do the testing?

You have basically 4 options: Have the water tested yourself; Hire someone to test it for you; Pressure the government to do it; Pressure the party responsible for the contamination to do it. Which option is best depends on your individual circumstances. Mostly, it depends on who can give you what you want: a reliable test with believable results.

If you test the water yourself, you run into a credibility problem: your opponents can say you "spiked" the sample with cleaning fluids or other chemicals to "prove" that the contamination exists.

The only way to overcome the credibility gap is to have someone else test the water for you, but this can cost big bucks. Also, if you don't know what to specifically test for, then the testing costs go up and up. Try to contact someone at a local university or college that has a chemistry laboratory. Striking up a relationship with someone in the local chemistry department could yield first-rate results with minimal financial expense. Pressuring the responsible party is good but only if you can identify who's responsible.

Your last option is pressuring the government.

What Do You Look For?

This depends on what is causing the problem. Where are the contaminates coming from? If it's a landfill, you need to find out what's been buried; if it's a gasoline station, then you look for oil and gasoline constituents; if it's a local factory or manufacturing plant, you'll need to find out what is made there. However, in most cases, you won't know what the source is, or, as is the case with most landfills, even what the wastes are. So what now?

Government agencies, with limited experience in the area of hazardous wastes, and with limited resources, tend to look for "traditional pollution parameters," including pH, specific conductance,

turbidity, chlorides, and a list of metals. EPA has set drinking standards for 10 metals, 6 persistent pesticides, and several other parameters, and has recently proposed standards for 9 organic substances (for a list of these substances, or more information, contact CCHW, Citizen's Clearinghouse for Hazardous Wastes).

These traditional parameters, however, do not reflect the diversity of potential environmental pollutants that could be leaching out of a land disposal site into your drinking water.

In addition, these indicators of general water quality can have seasonal changes in concentration that are unrelated to leachate migration. If these "traditional pollution parameters" are the only measures used to evaluate your water, "evidence" of contamination (with exception to the metals) is unlikely to be found. These measures were originally designed to test only for problems stemming from sanitary landfills or from bacteria and were intended only to set minimum standards for public drinking water systems. They were never intended as limits for acceptable environmental contamination.

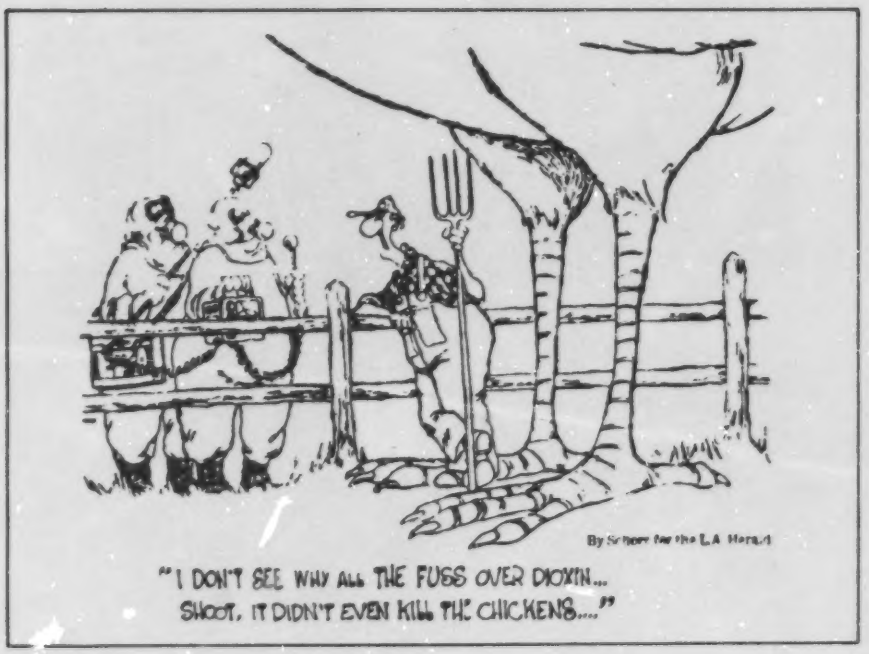
So what else do you want your tester to look for? EPA suggests looking at general "screening" compounds that are indicators of contamination: total halogenated organics (TOX), total organic carbon (TOC), pH and specific conductivity. These measures, however, are too general to serve as an early warning of threats to public health or the environment.

This is because this approach ignores the fact that chemicals hazardous to human health can migrate selectively into drinking water at concentrations far less than what the indicator parameters can detect. For example, while the concentration of total organics may not be very high in a sample, if a specific organic, such as benzene or toluene, makes up a significant portion of the sample, there would be a substantial health risk -- one which would be overlooked.

Furthermore, the "sensitivity" of the tests to measure TOX or TOC is not very high when compared to individual specific chemicals. In fact, testing for TOX and TOC requires 1000 times more contamination than looking for specific chemicals because of the high detection limits of these indicators.

The best approach may be to "look for priority pollutants." Although all toxic chemicals are not on this list, most of the "bad actors" are, and testing for the priority pollutants may be the most comprehensive and practical method for determining what is in your water.

Deciding what to test for and how to do it is not a simple task. Ideally, you want to get the most information for the least cost. The trick is knowing what to look for and how and where to look. You can't find contamination in a water table 10 feet below the surface if your sampler probe only goes down five feet. If you need help in deciding what tests to request, or in interpreting test data, contact CCHW.



Discussion Questions:

1. What are some of the problems that might arise in getting accurate measures of the pollutants in the water supply?

2. What are the advantages and disadvantages of general and specific tests?

3. How do the problems in testing make it difficult to enforce environmental laws?

4. Can we be sure of safety? How do we decide on what is an acceptable risk? Write to the EPA or local environmental agencies and ask how limits were arrived at and what ongoing research is being done to assess whether they should be changed or new ones added.

5. If we raise our safety standards, what costs will we have to pay? If we lower our safety standards, what costs will we have to pay?

From Dumpsite Cleanups, Environmental Defense Fund, Washington, DC, p. 22-24, & 36.

Analyzing Samples

Chemical analysis of surface water and groundwater

Results are only as good as the methods used to obtain them. Because studies done several years ago often used inadequate methods, they may not have reached correct conclusions about the types and levels of chemicals at your site. Before you rely on the results of any report, it is extremely important to evaluate the sampling and analytical methods used.

Two types of chemical analysis can be done on a sample—general tests, which give an indication of the possible level of contaminants in a sample, and the analysis of specific chemicals of concern. The kinds of general tests that are often performed on a sample are described in Table 1. As the entries in this table show, this testing is of limited usefulness in assessing the specific nature of a contamination problem. Results of general tests are difficult to interpret because they reflect a composite of substances and chemicals of varying degree of hazard. Trends can be identified, however, which should be further investigated using analysis for specific chemicals. The best of the general tests in most cases are total organic halogens, total organic carbon, and conductivity.

The analysis for specific chemicals requires first determining which chemicals to look for, since it is impossible to survey all known chemicals. This determination is easier if there is sufficient historical information to predict which chemicals are likely to be on the site. Seldom, however, is such thorough information available. Therefore, EPA generally analyzes for 129 "priority pollutants" (considered by EPA to be the chemicals in water most likely to threaten human health and the environment nationwide) plus the 10 or 20 chemicals that are found

Table 1
General Indicators of Water Pollution

ALKALINITY

The capacity of water to accept the additional acids (or bases) without becoming more acidic (or basic) itself. Alkalinity is imparted to water by such chemicals as carbonate and is not a good indication of toxic pollution.

BIOLOGICAL OXYGEN DEMAND (BOD)

The amount of oxygen required by microorganisms to decompose the pollutants in the water over a period of 5 days in the laboratory is called BOD. A high BOD indicates a high concentration of pollutants which break down naturally (called biodegradable). A low BOD cannot distinguish between a low concentration of biodegradable pollutants and a high concentration of nonbiodegradable pollutants. An extremely toxic waste may have a low BOD also because its toxicity kills the organisms available to degrade it.

CHEMICAL OXYGEN DEMAND (COD)

The amount of material capable of combining with oxygen in the water. Such material includes the BOD component and those chemicals which can change their form by accepting oxygen. Such chemicals include nontoxic chemicals such as sulfide as well as toxic metals such as chromium.

CONDUCTIVITY (also called Specific Conduction)

The ability of a sample to conduct electricity. High conductivity readings are caused by any kind of charged atoms (**ions**) in solution. Most often, high conductivity is caused by nontoxic substances such as salt, but it can also be caused by toxic materials. Because salt is often found in association with industrial waste, conductivity is sometimes an indicator of the presence of contamination.

DISSOLVED SOLIDS

The weight of material remaining after a *filtered* sample has been boiled dry. This measurement does not account for any materials which evaporate more quickly than water, such as many solvents. Since so many natural materials are dissolved solids, this is not a good indicator of toxic pollution.

HARDNESS

The amount of calcium and magnesium in the water. Hardness is not a good indicator of toxic pollution.

pH

A measure of the acidity of the water. Most unpolluted water has a relatively neutral pH of between 6 and 8. Values below 6 indicate an *acid* water, and values above 8 indicate a *basic* water. Acid and basic waters indicate the presence of pollution. However, neutral pH waters may also be polluted.

SUSPENDED SOLIDS (SS)

The weight of material which is filtered from a sample. Since many toxic constituents are dissolved in water, this is not a good indicator of pollution.

TOTAL ORGANIC CARBON (TOC)

An expression of the degree of organic contamination in a sample; commonly used as an indicator of industrial pollution. Because there are many natural sources of organic material (such as bacteria and leaves), this value must be interpreted carefully in order to be useful. In addition, the method used to measure TOC may remove volatile organics before they are measured (because it uses a process known as *stripping*) and may therefore not be accurate.

TOTAL ORGANIC HALOGENS

The concentraion of organic material which has a *halogen* (most commonly chlorine or bromine) attached to it. This category includes many pesticides and solvents and is a good general indicator of these classes of toxic pollutants.

TOTAL RESIDUE

The weight of material remaining after an *unfiltered* sample has been boiled dry; equal to the total dissolved solids plus the suspended solids. Because so many natural materials can contribute to dissolved solids, this is not a good indicator of toxic pollution.

TOTAL VOLATILE SOLIDS

The portion of the total residue which will burn between 100 and 500°C. An indicator of the degree of organic contamination. As with TOC, the value must be interpreted carefully in order to be useful. Nontoxic inorganics may raise the final reading somewhat.

TURBIDITY

The ability of a sample to scatter or absorb light rather than transmit it. Turbidity is caused by the presence of suspended matter such as clay, silt, microscopic organisms, and debris. It is not a reliable indicator of pollution.

in the highest concentrations at the site besides the 129. It is important to note that this list of 129 may not be appropriate for your site and should not be used automatically if records show that many other chemicals are likely to be present.

EPA has developed approved testing methods for analyzing all 129 priority pollutants. These methods are specified in the **Federal Register** of December 3, 1979, and in the EPA publication "Methods for Chemical Analysis of Water and Wastes" (EPA-600-4-79-020). In most cases, the methods require sophisticated laboratory equipment as well as highly trained personnel.

Because of the wide variety of industrial wastes, the methods specified by EPA cannot cover all possibilities and may not be suitable for some wastes. In some cases, modification of the standard method may therefore be necessary. Examples include:

(1) when interferences among chemicals in the mixture prevent an accurate determination of each chemical, or (2) when there is reason to believe a chemical is present that is toxic at concentrations that cannot be detected using standard procedures. Whenever a procedure is modified, the modification must be explained in the reporting of the results and the modification should have been approved by EPA.

The analytical methods specified by EPA group the 129 priority pollutants into sets of chemicals according to methods of analysis. Table 2 shows the groupings of chemicals by method of analysis and the **levels of detection** which can be achieved for each chemical.

The **levels of detection** for a chemical are the lowest levels which can be reliably picked up by the laboratory equipment. Often when data are reported, it will be stated that certain chemicals were "not detectable". It is important to realize that this does not mean that the chemical is not present. It simply means that the level of the chemical is lower than the level the particular analytical method can detect. The fact that a chemical is not detected is therefore, unfortunately, not an absolute indication of safety.

There are several different ways to express the concentration of chemicals in a sample. The four most common expressions are **milligrams per liter** (mg/l), **micrograms per liter** (mcg or µg/l), **parts per million** (ppm), and **parts per billion** (ppb). These expressions are called **units.** Milligrams and micrograms per liter tell you the weight of the chemical in a volume of water; parts per million and parts per billion tell the weight of the chemical per weight of water or soil.

In water, milligrams per liter and parts per million are practically equal and can be used interchangeably. A milligram is a weight equal to one thousandth (.001) of a gram. (One gram weighs about as much as 2 paper clips.) A liter is equal to approximately one quart. A level of PCB of 30 mg/l means that if you took about a quart of sample and you evaporated the liquid, you would have 30 milligrams of PCB left in the jar. The sample could also be said to have a PCB concentration of 30 ppm.

Micrograms per liter and parts per billion are also synonymous when dealing with water. A microgram is a millionth (.000001) of a gram. (Even smaller than a microgram is a nanogram (ng) which is a billionth (.000000001) of a gram.)

Table 2
Methods and Detection Limits

Chemical Name	Det. Limit (µg/l)
Method 603: Acrolein and Acrylonitrile	
acrolein	10
acrylonitrile	10
Method 608: Organochlorine Pesticides and PCB's*	
aldrin	0.1
dieldrin	0.1
chlordane	0.1
4,4'-DDT	0.1
4,4'-DDE	0.1
4,4'-DDD	0.1
endosulfan I	0.1
endosulfan II	0.1
endosulfan sulfate	0.1
endrin	0.1
heptachlor	0.1
heptachlor epoxide	0.1
a-BHC	0.1
b-BHC	0.1
d-BHC	0.1
g-BHC (lindane)	0.1
toxaphene	0.4
PCB Arochlor:	
-1016	0.1
-1221	0.1
-1232	0.1
-1242	0.1
-1248	0.1
-1254	0.1
-1260	0.1
Method 613: Tetrachlorodibenzo-p-dioxin	
2,3,7,8-tetrachlorodibenzo-p-dioxin	0.1
Method 624: Purgeable Organics	
acrolein	10
acrylonitrile	10
benzene	1
carbon tetrachloride	1
chlorobenzene	1
1,2-dichloroethane	1
1,1,1-trichloroethane	1
1,1-dichloroethane	1
1,1,2-trichloroethane	1
1,1,2,2-tetrachloroethane	1
chloroethane	1
2-chloroethyl vinyl ether	1
chloroform	1
1,1-dichloroethylene	1
trans-1,2-dichloroethylene	1
trans-1,3-dichloropropene	1
cis-1,3-dichloropropene	1
ethylbenzene	1
methylene chloride	1
chloromethane	1
bromomethane	1
bromoform	1

*Pesticides and PCB's are verified by Method 625 if detected at levels adequate for analysis by 625.

Table 7
Ambient Water Quality Criteria

Chemical Name	Maximum Allowable Level(µg/l)	Basis For Concern
Acenaphthene	20	taste & odor
Acrolein	320	toxic effects
Acrylonitrile	0.058	carcinogen
Aldrin/Dieldrin	0.000074	carcinogen
Antimony	146	toxic effects
Arsenic	.0022	carcinogen
Asbestos	30,000 fibers/l	carcinogen
Benzene	0.66	carcinogen
Benzidine	0.00012	carcinogen
Beryllium	0.0068	carcinogen
bis (2-chloro-isopropyl)ether	34.7	toxic effects
bis (chloromethyl) ether	.0000004	carcinogen
bis (2-chlorethyl) ether	0.03	carcinogen
Cadmium	10	toxic effects
Carbon Tetrachloride	0.40	carcinogen
Chlordane	0.00046	carcinogen
Chlorinated naphthalenes	None	
Chlorobenzene	None	
Chloroform	0.19	carcinogen
2-Chlorophenol	0.1	taste & odor
3-Chlorophenol	0.1	taste & odor
4-Chlorophenol	0.1	taste & odor
Chromium III	170	toxic effects
Chromium IV	50	toxic effects
Copper	1000	taste & odor
Cyanides	200	toxic effects
DDT	0.000024	carcinogen
Dichlorobenzenes[a]	400	toxic effects
Dichlorobenzidine	0.0	carcinogen
1,1 dichloroethane	None	
1,2 dichloroethane	0.94	carcinogen
1,1-dichloroethylene	0.033	carcinogen
1,2-dichloroethylene	None	
2,3-dichlorophenol	0.04	taste & odor
2,4-dichlorophenol	3090	toxic effects
	0.3	taste & odor
2,5-dichlorophenol	0.5	taste & odor
2,6-dichlorophenol	0.2	taste & odor
3,4-dichlorophenol	0.3	taste & odor
Dichloropropanes	NA	
Dichloropropenes	87	toxic effects
2,4-dimethylphenol	400	taste & odor
Dibutyl phthalate	34,000	taste & odor
Di-2-ethylhexyl phthalate	15,000	carcinogen
Diethyl phthalate	350,000	toxic effects
Dimethyl phthalate	313,000	toxic effects
2,4-dinitro-o-cresol	13.4	toxic effects
Dinitrophenols	70	toxic effects
2,4-Dinitrotoluene	0.11	carcinogen
1,2-Diphenylhydrazine	0.00042	carcinogen
Endosulphan	74	toxic effects
Endrin	1	toxic effects
Ethylbenzene	1400	toxic effects
Fluoranthene	42	toxic effects
Haloethers[b]	NA	
Halomethanes[c]	0.19	carcinogen
Heptachlor	0.00028	carcinogen
Hexachlorobenzene	0.00072	carcinogen
Hexachlorobutadiene	0.45	carcinogen
Hexachlorocyclohexane		
alpha-hexachloro-cyclohexane	0.0092	carcinogen
beta-hexachloro-cyclohexane	0.0163	carcinogen
gamma-hexachloro-cyclohexane	0.0186	carcinogen
tech-hexachloro-cyclohexane	0.0123	carcinogen
Hexachloroethane	1.9	carcinogen
Hexachlorocyclopentadiene	206	toxic effects
Isophorone	5200	toxic effects
Lead	50	toxic effects
Mercury	0.144	toxic effects
2-methyl-4-chlorophenol	1,800	taste & odor
3-methyl-4-chlorophenol	3,000	taste & odor
3-methyl-6-chlorophenol	20	taste & odor
Monochlorobenzene	488	toxic effects
	20	taste & odor
Monochloroethane	NA	
Monochlorophenols	0.1	taste & odor
Mononitrophenol	NA	
Naphthalene	NA	toxic effects
Nickel	13.4	toxic effects
Nitrobenzene	19,800	toxic effects
	30	taste & odor
N-nitrosodi-n-butylamine	0.0064	carcinogen
N-nitrosodiethylamine	0.0008	carcinogen
N-nitrosodimethylamine	0.0014	carcinogen
N-nitrosodiphenylamine	4.9	carcinogen
N-nitrosopyrrolidine	0.016	carcinogen
Pentachloroethane	NA	
Pentachlorobenzene	74	toxic effects
Pentachlorophenol	1010	toxic effects
	30	taste & odor
Phenol	3500	toxic effects
Polychlorinated biphenyls	0.000079	carcinogen
Polynuclear aromatic hydro-carbons	0.0028	carcinogen
Selenium	10	toxic effects
Silver	50	toxic effects
1,2,4,5-tetrachlorobenzene	38	toxic effects
1,1,1,2-tetrachloroethane	NA	
1,1,2,2,-tetrachloroethane	0.17	carcinogen
Tetrachloroethylene	0.80	carcinogen
2,3,4,6-tetrachlorophenol	1	taste & odor
Thallium	13	toxic effects
Toluene	14,300	toxic effects
Toxaphene	.00071	carcinogen
Trichlorobenzene	NA	
1,1,1-trichloroethane	18,400	toxic effects
1,1,2-trichloroethane	0.6	carcinogen
Trichloroethylene	2.7	carcinogen
2,4,5-trichlorophenol	2,600	toxicity
	1.0	taste & odor
2,4,6-trichlorophenol	1.2	carcinogen
Trinitrophenols	NA	
Vinyl chloride	2.0	carcinogen
Zinc	5000	toxic effects

[a] Includes any combination of 1,2-dichloro; 1,3-dichloro; and 1,4-dichlorobenzene.

[b] Includes any combination of chlorophenyl phenyl ethers; bromophenyl phenyl ethers; and polychlorinated diphenyl ethers.

[c] Includes any combination of chloromethane, bromoethane, methylene chloride, bromoform, bromodichloromethane, trichlorofluoromethane, and dichlorodifluoromethane.

TEACHER'S INTRODUCTION TO LAB ACTIVITY 3

The Effect of pH and Salt on Living Organisms

Since students have learned that abnormal salt content and pH can be hazardous, the aim of the following experiment is to provide evidence that this is true. Once again it is important that students understand that the results of their experiments, whether positive or negative, are not final proof. As in the last activity, a discussion of the reliability of animal experimentation would be interesting. In addition, the scientific method should be emphasized. Students should understand that all hypotheses are subject to further testing, and that in order to support one's hypothesis, this testing should be done.

The following experiment can be performed using various organisms: Euglena or other fresh water protozoa, bacteria (preferably soil bacteria, although E. coli will do), or plants. For protozoa or plants, stock solutions of distilled water with different salt concentrations and pH should be prepared in amounts sufficient for the entire class. These solutions will be used to grow protozoa in or to water plants. If bacteria are being used, they can be grown in nutrient broth that differs in pH and salt concentration. The bacteria can then be plated on nutrient agar, and students can count the number of colonies. Plant structures can be observed to see if they are affected by the solutions.

The experiment presented here using Euglena can be elaborated on depending on one's equipment. For instance, a colorimeter would provide better quantitative measurements of population growth, but since most schools lack such devices, students are instructed to count the number of organisms observed in a microscope's field in a certain amount of time. This method will provide a relative reading of population. In order to save class time, the protozoa can be grown in the various solutions for a day before the lab is actually done. If time is not short, students can grow their own samples. The former suggestion is presented here.

STUDENTS' LAB ACTIVITY 3 WORKSHEET

The Effect of pH and Salt on Living Organisms

Abnormal pH and salt concentrations can suggest the presence of hazardous waste. The intention of this experiment is to study the effects of these factors on organisms, and determine what concentrations of acid, base, and salt are actually toxic to the organisms being studied.

Materials:

- Miscroscope
- Depression slide
- Cover slip
- Stock solutions with various pH and salt concentrations
- Euglena

Procedure:

1. Obtain a microscope and a clean depression slide.
2. With a medicine dropper, take a sample from one of the growth solutions provided by your teacher, place it on the slide, and cover it with a cover slip.
3. Place the slide on the stage of your microscope, and focus using low power.
4. In order to determine the RELATIVE number of living organisms in each solution, you will count the number of organisms seen in the field of the microscope in one minute. When you are ready to start counting, have your lab partner say go and then time you for half a minute (if there are a lot of organisms, you may have to estimate).
5. Record the number in the appropriate place in the chart below.
6. Rinse your slide with distilled water.
7. Repeat this procedure for each solution.

	SALT CONCENTRATIONS					
	0%	.2%	.5%	.7%	1%	3%
# of organisms observed						

	pH					
	1	3	5	7	9	11
# of organisms observed						

Graph the number of observed organisms vs. pH and the number of observed organisms vs. salt concentration.

Compare your results with those of your classmates.

Discussion:

1. Why is it important to look at class data?

2. What ranges of pH and salt concentration seem to affect these organisms adversely?

3. Can you conclude that your results would have been similar no matter what organisms were used? Explain.

4. How would you modify this experiment to give you more information on the effects of acids, bases, and salts on other living organisms?

5. How would you determine acceptable limits for toxic substances in water?

6. Find out how the EPA sets its standards.

TEACHER'S INTRODUCTION TO LAB ACTIVITY 4

Detection of Heavy Metals in Water

This activity is a simulation of how heavy metals are detected. Students will add galvanized iron (iron coated with zinc) and lead to water and later observe how toxic deposits are formed. The class should understand that although zinc itself is not terribly toxic, the presence of zinc in water can indicate lead and cadmium contamination also, since impurities of these metals are often found in zinc. Caution students not to touch the metal deposits. It is necessary to use distilled water and pyrex beakers so that reactions with lead do not take place. Because of such reactions, fewer incidents of lead poisoning are found in communities with hard water. A fourth beaker containing hard water could be used to demonstrate this effect.

Once again, stress the importance of good experimental design and the necessity of a control. Students should realize that positive results indicate the presence of some substance, but do not prove conclusively the existence of zinc or lead. Likewise, negative results do not mean the substances are not there, particularly because they are dealing with such small quantities. (Adapted from: Sootin, Harry. EASY EXPERIMENTS WITH WATER POLLUTION. N.Y. Four Winds Press, 1974, pp.86-89.)

STUDENTS' LAB ACTIVITY 4 WORKSHEET

Detection of Heavy Metals in Water

Heavy metal deposits are often formed in drinking water after dissolving from pipes. These pipes are made up of galvanized iron, iron that is coated with zinc. The purpose of the following experiments is to see how these deposits are formed and how they can be detected.

Materials:

- distilled water
- 3 100 ml beakers
- straw
- clean elbow of galvanized iron
- 3 medicine droppers
- 3 clean slides
- lead sinker
- steel wool
- 3 watch glasses

Procedure:

1. Add about 50 ml of distilled water to 3 100 ml beakers.
2. Gently blow through the straw into each beaker for about a minute to carbonate and oxygenate water.
3. Add galvanized iron to one of the beakers.
4. After rubbing the sinker with steel wool and washing and drying it, place it in the second beaker.
5. Cover all 3 beakers with watch glasses, and set aside.
6. After 24 to 48 hours, place a few drops of water from each of the beakers on 3 clean labeled slides. Use one dropper for each or wash the dropper in distilled water between each.
7. Allow the drops to dry, and then examine the slides for any deposits.

Results:

1. Draw a sketch of the 3 slides.
2. Is there evidence of some heavy metal deposits? Explain.
3. Why is the beaker of plain water needed?

Discussion:

How might lead or zinc get into your drinking water?

TEACHER'S INTRODUCTION TO "ACTION"

This section of the curriculum guide is designed to have students use and act on their knowledge of the toxic waste problem. They will be asked to evaluate the actions of others and think about what they would have done in the same situation. In a mock congressional hearing, they will take on some of these roles and demonstrate their understanding of the many different sides of the issue. Finally, they will decide if they want to participate in a detailed study of hazardous waste production and disposal in their own community, a study that could be made public to benefit that community.

The first reading in this section presents Rachel Carson as a model of a scientist who took it upon herself to face the government and industries in order to achieve a goal she believed in, the protection of the environment. After reading this piece, discuss how our country might be different today if she and others had not taken action. You might ask students to think of other examples of scientists who have taken action because of their values (e.g. ecologists against genetic engineering).

In the following reading, Denmark is given as an example of a country that has taken action to establish a different system of toxic waste management. Discuss whether or not this system would be feasible for the U.S., what the consequences of the system would mean, and why interest groups would make its legislation terribly difficult.

Students will then have an opportunity to examine what our government is currently doing about toxic waste. They will be able to select from among three activities: assessing a candidate or office holder's viewpoint and record, following a piece of legislation, or assessing the quality of the local or state agency's efforts in the area of toxic waste disposal. Help them draw the relationship between their scientific investigations and policy decisions made on this issue. Be careful to balance divergent viewpoints so that students can better understand the complexity of the decisions that are being made.

Most students enjoy simulations. However, when doing the mock Congressional hearing outlined in the next activity, encourage students to argue from their role's perspective, not from their own. The students' viewpoints should be based on information from this unit or from direct interviewing of people in similar positions as their roles; for example, those playing representatives of local industries might call some companies in the area to ask how they might react in a similar situation. Remind the class that any situation in which there is a toxic waste problem is very complex, and that, therefore, they might need to

compromise. Compromise can be offered by any group or by the congressional committee. The size of the class will determine how many students are assigned to each role and whether or not all the roles will be used. Instruct the subcommittee to run the hearing and to evaluate the situation on the basis of the arguments presented and their own understanding of other investigations. Resources of case histories could be made available.

Alternatively, conducting the hearing around local hazardous waste issues may be preferable. This activity would be particularly appropriate if students have obtained historical data on local production of waste. Collaboration with both the math and social studies departments of your school could be beneficial at this time.

The last activity is a culmination of all that has come before it. However, it is an activity that we feel should be left optional for those classes that want to contribute to handling the toxic waste problem in their community. The class should read and discuss the Investigation Guide and then decide if they want to continue their study. If several classes want to contribute, the work can be broken down between classes. A steering committee should be elected to coordinate the investigation. Some of the information can come from work that was done earlier in the unit.

Once the study has been completed, the class or classes should discuss what they want to do with it. They might like to contact local newspapers, show it to political figures, or present it to the school and parents. Their decision to act or not should be their own perogative. Remind them that their action or inaction is based on an educated opinion and that is what is important.

Making a Difference: The Story of Rachel Carson

Today, Americans realize that pesticides and other toxic substances pose potentially grave dangers to life. Because of this knowledge, DDT is no longer used and new pesticides have to undergo rigorous testing to be approved by the government for use. We take it for granted that the government is protecting the environment, but it was not always this way. And even now there is a debate in government about how far we should go to protect the environment and what protection entails.

Much credit for our awareness of the dangerous effects of pesticides must be attributed to one woman, Rachel Carson. In 1962, she published Silent Spring which described how pesticides could harm the environment. Ms. Carson understood that all organisms in nature are interrelated, and that damage done to one species could harm others. Therefore, using poisons to wipe out pests eventually could threaten other animals, plants, and humans. Until Silent Spring, people were generally unaware of how chemical pesticides could affect us. After its publication, people took action. The following story tells how one person can produce such a difference in the world.

Though trained in biology, Rachel Carson was a successful writer. In the 1950's, she became aware of scientific reports that DDT was finding its way into many animals at whom it had not been aimed. Unlike some chemicals which break down naturally in the environment, DDT remains toxic for a long time. Therefore, DDT sprayed on crops could wash into water systems where it eventually might reach lakes or oceans for fish to absorb. Likewise, animals feeding on the crops could pass the chemical through the food chain. Thus, even humans could absorb it. Even though Rachel Carson knew of these reports, she took no action. It was not until one individual, Olga Huckins, wrote her about pesticides killing birds in a wildlife preserve that she began her crusade against pesticides. This incident is an example of how one person's expression of concern to someone like Rachel Carson can start a process that leads to important change.

Rachel Carson had become horrified by the unrestricted, widespread use of pesticides. She knew that the government and industries which profited from these chemicals did not want to examine the possible harm they could cause. Therefore, she was determined to gather the facts, and to get the public involved to create pressure for change. Her task was to take a huge mass of scientific information and translate it into a story that untrained people could understand. Thus, she began to write Silent Spring.

Because of her insistence on unquestionable facts and analyses, the book took many years to write. Basically, she was a scientist, committed to empirical thinking and to original research. She knew that her work would receive criticism, and that the best way to combat such attacks was with sound data.

While many major government and private institutions concerned with chemicals, agriculture, and food processing attacked Silent Spring, the book was defended by respected scientists. President Kennedy, too, was affected by the news of the book and the public concern it was arousing. He formed a presidential committee to study the use of pesticides. Its report affirmed Carson's findings, and called for the termination of the use of toxic, non-degrading chemicals. In writing Silent Spring, Rachel Carson had two goals: to alert and activate the public, and to prompt the government to bring about change. She accomplished both.

(Adapted from Graham Frank, "Silent Spring: The Genesis and the Storm." Audubon, Jan. 1970, vol. 72, #1, pp.70-102.)

Discussion Questions:

1. What spurred Rachel Carson's interest taking action about the issue of pesticides?

2. Why did she feel it was important to build a solid case for her position?

3. Why do you think people criticized her research?

4. What risks did she take in publishing her book?

5. How were her findings confirmed?

Denmark: An Example of a Toxic Waste Treatment Program

Unlike the United States, Denmark has found an effective way to take care of its toxic waste problem. Instead of leaving waste treatment and disposal to private companies, all of Denmark's industrial and residential waste is taken to municipal sites or shipped directly to a national treatment center. The municipal centers then transport the waste to the national center, Kommunekemi.

Waste generators are charged for the transport and disposal of their waste, and must provide documentation of the contents of the waste. The national waste disposal laboratory then checks the accuracy of this information. The different kinds of waste are then sent to the appropriate treatment plant (oil, inorganic, incinerator, or controlled landfill). All of these plants are monitored carefully. The plants recycle as much of the waste as they can. What cannot be recycled is incinerated if possible and used to generate steam for heating. Therefore, a much smaller amount of refuse is put into the landfill than in the United States.

1. Do you think it would be feasible and advantageous to use such a system in the U.S.? Explain.

2. What would be the implications of this program for the government, industry, and private citizens? (Consider both the positive and negative aspects, e.g. better environmental quality but more time needed by individuals tc sort their waste).

Examining Government Decision-Making

As you have seen, our government makes many decisions about toxic waste disposal. Below are three activities which can help you assess what our government is doing about the issue. Your class might want to choose one or divide into groups and do all three.

ACTIVITY 1

Based on your research in this unit, develop a questionnaire on toxic waste disposal for local, state and national political figures and candidates. Either send the questionnaire to them or, better yet, invite them to your class to discuss their positions on the topic. If it is an election year, chart the views of the different candidates. Evaluate the responses as to:

1. How knowledgeable the person was about the problem.

2. The advantages and disadvantages of the solutions he or she proposed.

3. On whom does he or she place primary responsibility for the costs of cleanups.

4. The long-term solutions he or she would work towards.

5. How important the issue is to him or her.

Write to both business and environmental groups for their evaluation of the candidate or office holder's position. How do these compare with the class's assessment?

ACTIVITY 2

Find out from your state representative or local Congressperson what legislation is pending on toxic waste disposal. Have them send you copies of the legislation. Find out what local environmental, business, and community groups think of this legislation. What are they doing to either support or defeat it? Through the news and follow-up contacts with these representatives trace the path this legislation takes. Who has influence on the process? How are decisions made? What changes are made in the bill? How well is the public informed about it? How well is it implimented? If in doing this your class determines that it strongly supports the bill, strongly disagrees with the bill, or has a better idea, get involved in the decision-making process. You might be able to testify at hearings, write a new bill or amendment and have your representative submit it for you, or publicize the bill in your community and enlist support for your viewpoint.

ACTIVITY 3

Finally, write to the local and state governmental agencies which have responsibility for overseeing toxic waste disposal and find out what

is currently being done and what is planned for the future. Write to other towns, states or the Federal government and find out how other areas are handling the issue. What creative programs are being initiated? How quickly are these agencies moving? How well are they funded and staffed? Is their leadership aggressive or cautious? Write to local business and environmental group for their views on your local or state efforts. Assess how effectively your community or state is handling the problem.

A MOCK CONGRESSIONAL INVESTIGATION

Your class now will hold a mock congressional hearing on the toxic waste problem in Durham, Connecticut. Groups of students will act out different positions in the controversy. The role playing should be based on the history given below and on the information you have learned through this unit. Your group should discuss its stand and appoint one spokesperson. Depending on your role, it might be helpful to contact similar people in your area and ask them how they would react in such a situation. For example, the people playing the governor's representative could contact the governor's office or the state office for environmental affairs. Try to be as true to your part as possible without letting your own feelings interfere. After hearing testimony from all participants, the members of the congressional subcommittee will decide on how the problem should be handled. Their options are: to do nothing, to provide money from the Superfund with or without sueing the generator for restitution of this money, to mandate a state supported cleanup, or to mandate that the generator conduct the cleanup. They should present and explain their decision.

Roles:

1. Students and faculty of Durham High School.
2. Parents of students attending Durham High School.
3. State Dept. of Solid Waste Management (the agency that discovered the contamination after complaints from the school).
4. Representatives from Connecticut's Governor's office.
5. EPA experts on toxic waste.
6. Sibbley, Inc., the generator.
7. Representatives of several other companies in the area that also generate hazardous waste (players can decide how they handle theirs and whether or not they want to support Sibbley).
8. Representative from the mayor's office (consider whether the town wants to jeopardize its image and whether it wants to scare away industry).
9. Environmental group.
10. Congressional subcommittee members.

Connecticut

Over 1.2 million Connecticut residents, almost 40 percent of the state's population, depend on groundwater. Almost half get their water from private wells, which are rarely tested for chemical contaminants. A 1981 state hazardous waste inventory indicates that one quarter of the state's towns had already experienced groundwater problems.

Connecticut exemplifies some specific problems faced by older industrial states with high concentrations of small manufacturing facilities. According to a 1979 state survey, many Connecticut manufacturing facilities utilize a "seepage impoundment" process that deliberately allows contaminated waters to seep into the ground "to aid in the dewatering of the metal hydroxide sludges." There are over one hundred fifty active and nineteen abandoned seepage impoundments of this type in Connecticut. The state conservatively estimates that over half the metal plating and finishing wastes placed in these impoundments could eventually reach groundwaters.

In 1970, students and faculty at Durham High School began complaining about an unusual odor in the school's drinking water. Tests indicated that the water was contaminated with the solvents tetrachloroethylene and chloroform. Subsequent investigations determined that the most likely source of the contamination was an impoundment on the property of Sibbley, Inc., a metal plating operation located within a few hundred feet of the school water well. Although discharges into the impoundment have been stopped, the school must continue to use an activated carbon filter system to cleanse the contaminants from the water.

(Epstein, et al., p.84.)

Your Research Plan for the Investigation

The goal of this project is to compile a document which will not only help you learn about hazardous waste in your community, but also will be valuable to the community itself. Very likely, no other description of your town's hazardous waste has been written. One of the first places you will want to check is the town library, in order to learn whether anything in fact has been published on the subject. You may find state or EPA records that mention specific aspects of the question, and you should include these in your material.

Copies of your investigation may be welcomed by the local newspaper(s) as a source of information for their reporters. You may also wish to provide the town library with a copy. Since there is the chance that members of the public will use your material, it is doubly important to footnote or otherwise indicate the sources of your information, so the reader will know where to go for verification or further research.

The class may wish to divide into teams, with each group taking a different part of the outline. The teams should meet separately, plan the approach, then come back together to see if any two teams intend to call on the same source of information. If so, it may be good to comine the questions and/or visits.

Here are more specific suggestions for gathering information:

I. Introduction/Overview

A. General (danger and prevalence of hazardous waste, forecasts of future increases in production, effectiveness (or ineffectiveness of disposal methods, etc.)

B. Our town (Has our town had problems with hazardous wastes in the past? Is it better to wait for problems to develop or try to head them off?)

II. Survey of laws and agencies

A. Contact the water works agency for copies of summaries of laws relating to drinking water. Try to get specific information regarding testing of the water, minimum standards of purity, etc. Learn which state agencies also have jurisdiction over our town's water.

B. Contact the sanitation department (or the equivalent) for ordinances relating to garbage, trash, and hazardous materials disposal. Are there any rules prohibiting households from including toxic materials in ordinary trash or garbage? Does the city have legal provisions for separate collection of dangerous materials from homes?

C. Contact your state environmental protection office for copies or digests of relevant state laws. Perhaps they will also send material relating to federal laws.

D. Local law offices, libraries, or environmental groups may also be helpful by providing copies of pertinent laws.

III. Drinking water

A. Where does your city obtain its drinking water? Has it always used this source, or were there others in the past? What were they, and why did the city change?

B. What, if any, undesirable matter is contained in the water before treatment? How effective is treatment? Do measurable amounts of certain minerals or chemicals remain after treatment? Describe treatment of the water. Are some substances ignored which should be treated? Are tests for mercury performed, for example?

C. What are the chances that some of the chemicals you pour down the drain or throw in the garbage may end up in the water supply? Where is the present city landfill located, what is its design, and what are the chances that leakage (leachate) may eventually reach the water supply? See if you can get copies of state inspections of your city's landfill. What are chances that any of the dumps described in part V. might be or become threats?

IV. Production and disposal of hazardous wastes

A. Industrial

Quite likely local or state agencies have done some of this work for you. See if you can ferret it out. If you live in a large city and no survey of industries has already been made, you may prefer to select a few plants and gather information on them. Try to get historical data showing whether production of wastes is increasing, and if so, at what rate. Use this data in constructing your computer model.

B. Household wastes

List the toxic substances which appeared most often in your survey of your own homes (and of neighbors, if the survey included them).

C. Oil from service stations

The companies which collect used oils from service stations should be able to supply you with historical data showing annual amounts collected over several years. Perhaps this will be a way for you to detect a trend in the amount being

produced: Is it decreasing, increasing, remaining stable, or erratic? Is the oil recycled? Where and by what company? When people change their own oil at home, how do they dispose of it? Can they bring it to a service station that will add it to oil being properly disposed of?

V. Description and location of dumps

Locate as many closed dumps as you can. There are probably old "city dumps" long since filled and now used for playgrounds or other purposes. Does the vegetation (if any) growing on these sites look healthy? Are the sites still monitored? How and how often? Will long established plants that have active disposal sites reveal locations of earlier sites? Information on the geological structure and groundwater or aquifers beneath these sites should be available from one or more sources (see Sources at end of this unit).

VI. Summary

What important facts have emerged from your investigation? What is the outlook for the future? Is the amount of hazardous waste produced in your area likely to increase, remain the same, or decrease? How satisfactory are treatment and disposal methods? Are plans for the future adequate?

VII. Recommendations

More study/education? Legislation? Action? (at individual, community, or wider level?)

Can you recommend ways that production of hazardous waste can be reduced?

REFLECTION

1. What are some of the most important things you learned from this unit?

2. How can a knowledge of natural science, including biology and chemistry, help you be a healthier individual and a better citizen?

3. Has a knowledge of the scientific method helped you in planning and conducting the INVESTIGATION? In what ways?

4. Did your INVESTIGATION lead to a specific benefit to the community? Do you think that with more time the study could have been more valuable to you and to the community?

RESOURCES

AGENCIES:

Citizens Clearinghouse on Hazardous Waste
P.O. Box 7097
Arlington, VA 22207

Citizens for a Better Environment
59 E. Van Buren, Suite 1600
Chicago, IL 60605

Concern, Inc.
2233 Wisconsin Ave., N.W.
Washington, D.C. 20007

Environmental Defense Fund
1525 18th St., N.W.
Washington, D.C. 20036

League of Women Voters
1730 M St., N.W.
Washington, D.C. 20036

National Wildlife Federation
1412 16th St., N.W.
Washington, D.C. 20036

Sierra Club
530 Bush St.
San Francisco, CA 94108

Solid Wastes Management Assoc.
1120 Connecticut Ave., N.W.
Washington, D.C. 20036

U.S. Environmental Protection Agency
401 M St., N.W.
Washington, D.C. 20460

U.S. Geological Survey
Water Resources Division
National Water Data Exchange
Reston, VA 22092

RESOURCES

BOOKS:

A Hazardous Waste Primer. Wash., D.C., League of Women Voters, Education Fund, 1980.

Dumpsite Cleanups. A Citizen's Guide to the Superfund Program. Wash., D.C., Environmental Defense Fund, 1982.

EPA Journal. Wash., D.C., U.S. Environmental Protection Agency.

Epstein, S.S., Brown, L.O., & Pope, C. Hazardous Waste in America. San Francisco, Sierra Club Books, 1982.

Federal Register. Wash., D.C., U.S. Environmental Protection Agency, 1983.

Hazardous Waste: A Community Action Guide. Wash., D.C., Concern, Inc., 1981.

Hazardous Waste Information. Wash., D.C., U.S. Environmental Protection Agency, 1980.

Lash, J., Gillman, K. & Sheridan, D. A Season of Spoils. N.Y., Pantheon Books, 1984.

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